VIEW OF CAP-LA-HÊVE, FROM THE BEACH AT FRASCATI'S.

a. Shell-Sand Cliff at the back of kilns.

THE GEOLOGIST;

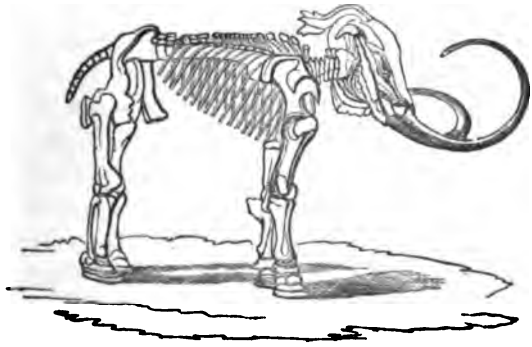
A POPULAR ILLUSTRATED

MONTHLY MAGAZINE

OF

GEOLOGY.

EDITED BY S. J. MACKIE, F.G.S., F.S.A.



LONDON:
LOVELL REEVE & CO., 5, HENRIETTA STREET, COVENT GARDEN.
PARIS: J. ROTHSCHILD. BERLIN: ASHER & CO.
1864.

PRINTED BY
JOHN EDWARD TAYLOR, LITTLE QUEEN STREET,
LINCOLN'S INN FIELDS.

PREFACE.

'The Geologist,' at which I have laboured with assiduity and pleasure for more than six years, is brought unexpectedly to a close, with only half the quantity of matter usually devoted to a volume. A new geological magazine is announced, and having received an intimation from my publishers that to continue 'The Geologist' in rivalry with it would be attended with anxiety, and perhaps with loss, I have decided to retire from the field rather than take part in a contest that might prove injurious to both.

To give up this monthly intercourse with so many friends at home and abroad is, naturally enough, a source of regret to me, if not of pain. I labour, however, neither to gratify vanity nor for gain. The honest wish of spreading and advancing knowledge, and of giving free scope to the expression of geological theories and criticism, has been my motive for maintaining this periodical, and I may with truth assert that, during the period of its publication, it has been a means of free intercourse among all classes of geologists. To its pages it has been my pride that ALL should, fairly and freely, have admission.

My duties are done; and in for ever closing this work I will but add, that had there been any option left with me I should have preferred to have completed this volume in full to the end of the year. There are, however, stronger reasons than I can control for closing it at once. With all my numerous friends I beg, however, to remain in personal correspondence; while the *new* works I hope to project will soon put me again in open communication with the world, and will, I trust, prove not merely my desire but my capacity to supply useful materials for the labours of others, and to do something myself also for the advance of a very imperfect but very noble science.

There is one labour—the first part of the first instalment of which will appear, I believe, on the 1st of July—my projected 'Illustrated Catalogue of British Fossils,' for which I hope to obtain *very extensive support.* The printing of the first portion, complete in itself, 'An Illustrated Catalogue of British Fossil Sponges,' has already been commenced, and in it the original figures, descriptions, and bibliography of all the described British fossil species will be given, with original notices of those new kinds which have already come to my knowledge, or may hereafter do so before the completion of the volume. As this work will be exceedingly full, it will entail a very heavy outlay on the publisher, not to be compensated, unless those geologists, who are not sponge-collectors, come freely to its support, in the faith that the success of this gigantic undertaking can only be accomplished by mutual help, if ultimately every department of British Palæontology is to receive similar illustration.

All but my last words are penned; I devote them to my best wishes for the welfare of all my friends.

S. J. MACKIE.

27th May, 1864.

THE GEOLOGIST.

JANUARY 1864.

ON THE EARTH'S CLIMATE IN ANCIENT TIMES.

By the Editor.

For some time past we have been drawing attention to some of the dicta of Geology, which appear to have a less solid foundation than they should have to authorize the positive manner in which they have been enunciated. Similar doubts on some points would appear not to be absent from other minds. Mr. Page has just issued a little work reviewing the state of the popular doctrines of our science, and Mr. Sterry Hunt has appropriated to the explanation of the higher Palæozoic climate Dr. Tyndall's memorable researches on the relations of gases and vapours to radiant heat. Heat, from whatever source it may proceed, passes through hydrogen, oxygen, and nitrogen gases and *dry* air, with nearly the same facility as through a vacuum, and these gases are thus to radiant heat what rock-salt is amongst solids. Glass and some other substances which are readily permeable to light and to solar heat, offer, as is well known, great obstacles to the passage of radiant heat from non-luminous bodies, and many vapours and gases have a similar effect in intercepting the heat from such sources. Thus, for a vacuum the absorption of heat from a body at 212° Fahr. is represented by 0, that by dry air as 1, while the absorption by an atmosphere of carbonic acid gas is 90; by one of marsh-gas, 403; by olefiant gas, 970; and by ammonia, 1195. Olefiant gas at 1 inch tension produces an absorption of 90°, and carbonic acid gas in the same state, an absorption of 5·6. The small quantities of ozone present in electrolytic oxygen were found to raise its absorptive power from 1 to 85, and even to 136; and watery vapour present in the air at ordinary temperatures produces an absorption of heat represented by 70 or 80. Air saturated with moisture at the ordinary temperature absorbs more than 5-100ths of the heat radiated from a metallic vessel filled with boiling water; and Tyndall calculates that of the heat radiated from the earth's surface, warmed by the sun's rays, one-tenth is intercepted by the aqueous vapour within 10 feet of the surface. The influence of moist air upon the climate of the globe is like that of a covering of glass,—it allows the sun's rays to reach the earth, but prevents to a great extent the loss by radiation of the heat thus communicated. During the long nights, however, the radiation which goes on into space causes the precipitation of a great part of the watery vapour of the air; and the earth, deprived of its protecting shield, becomes rapidly cooled. "If now," says Mr. Hunt, "we could suppose the atmosphere to be mingled with some permanent gas, which should possess an absorptive power like the vapour of water, this cooling process would be in a great measure arrested, and an effect would be produced similar to that of a screen of glass, which keeps in the temperature beneath it directly by preventing the escape of radiant heat, and indirectly by hindering the condensation of the aqueous vapour in the air beneath." Such a heat-absorbing gas might have existed, and, if geologists are right in their old notions about the abundance of carbonic acid gas in the days of the luxuriant coal-plants, did so; and Mr. Hunt seizes on this idea at once, and considers there are "the best of reasons for believing that during the earlier geological periods all of the carbon since deposited in the forms of limestone and of mineral coal existed in the atmosphere in the state of carbonic acid;" and he also considers other gases may have aided. "The ozone which is mingled with the oxygen set free by growing plants, and the marsh-gas which is now evolved from decomposing vegetation under conditions similar to those then presented by the coal-fields, may by their very great absorptive power have very well aided to maintain on the earth's surface that high temperature, the cause of which has been one of the enigmas of geology."

So far, very good; Mr. Hunt seemingly prefers carbonic acid in the air to the supposititious molten mass inside our globe. If there were a former higher climatal temperature of our planet, and such abundance of free carbonic acid in our atmosphere, doubtless all would happen just as Mr. Hunt indicates. But was there such an amount of freé carbonic acid? and if so, whence did it come? Carbonic acid one would regard as the result of animal or igneous combustion. We could scarcely derive it from the piscine and mollusk life of the early geological life-periods; nor is it a bit clearer that there were any really igneous causes at work to produce it in such volumes. We would rather regard it as the resultant from the undoing of something else; if so, it was probably generated continuously, not in volumes. In nature too little remains free for any length of time. Length of time, with small quantities of carbonic acid, would accomplish the same result for vegetation as large quantities and very rapid action; and we have no right to conclude that the Coal period was not a long period. Moreover, we have no experiments to teach us that plants grow more rapidly and solidly in an abundance of carbonic acid than in purer air with only a slight amount of carbon in it. The *luxuriance* of vegetation is synonymous with *fixation* of *carbon*, and there is much to make us think that this takes place more freely and perfectly in proportion to the intensity of light and the purity of the air. Is it not the sunshine, and not the volume of carbon, that is the cause of luxuriance?

Mr. Hunt appends to his paper a notice of an article by the late Major E. B. Hunt, of the United States Engineers, "On Terrestrial Thermotics," published in 1849, in the Proceedings of the American Association, in which the Major argues that the temperature of the earth's surface increases with the barometric column, and that the atmospheric mass must have been greater in the earlier geological periods by the amount of carbon and carbonic acid since extracted from it, and that therefore the general temperature of the earth's surface must have been higher. To this effect of the carbonic acid Professor Dana adds the suggestion that the excess of moisture in the Carboniferous age would also have contributed to increase the weight of the atmosphere. Given the premises that the atmosphere consists of the residual gases remaining after the consolidation of the globe and the reduction to the liquid state of its seas and of the greater volumes of water evaporated from it in consequence of its previous supposed higher temperature, we might grant the values of these additions as considerable, especially the last. As it is, we admit the idea of Major Hunt is clever.

But a question or two may, however, be asked with advantage. We have, in former speculations, contested for a consideration of the possible interference of grand physical operations in effecting the alteration from remarkable former conditions of our planet. Let us glancingly turn our eyes now in the same direction. If the earth's orbital velocity and her rotation round her axis are due to some originating impulse, such as projectile force would be to a cannon ball, then the orbital velocity and the rotatory motion must have been higher in the early ages of our planet than at present, because if there be any friction opposed to motion in space that friction is an antagonistic power, that, no matter how slowly, would bring down and ultimately cancel the amount of the initial velocity, and reduce the object to a state of rest. If we consider the effects of a higher orbital velocity, we shall find it would give rise probably to a larger extent of orbit, and also to a higher rotatory motion. Now the higher rotatory motion, although it would give no more sunshine to the earth, would so far counteract the effects of night-radiation into space as that if the revolution were twice as quick, the effect of night-radiation would possibly not be half what it is, because the radiation being at a given rate for a given time, it could only attain half the diminution of temperature in half the time, and we know that the more *intense* the cold the more vegetation is *checked*. It might therefore happen that half our present intensity, never exceeded, might never bring vegetation to a standstill, and there might be a perpetual growing vegetation through both winter and summer under such favourable conditions. If the orbit were increased, these favourable conditions might, it may be seen at the first glance, be counteracted by the greater remoteness from the sun; but we have yet to learn that the nearer the sun the hotter would be our planet's general climate, or the further away greater in proportion the diminution of light. Is light dependent on the density of our atmosphere, and does it travel on as simple motion in the ethereal realms beyond our atmosphere? Is it the friction of waves of motion through our air that gives to light its luminosity? The sunlight falling on Neptune must be powerful, for the reflected beams from that far distant planet to reach us as definitely as they do in our powerful telescopes? And I do not know that the light from Jupiter is less intense than the light from our moon, quantity for quantity. But I do not want to take this subject away from the immediate bearings it may have on the former temperature of our planet.

If the light and heat of sunshine be due to the frictional resistance of the earth's atmosphere to the waves of motion proceeding from the sun's combustion or incandescence, the thicker the atmospheric stratum round a planet and the denser its condition, and the bigger the planet and the more remote its position from the sun, the denser it would be,—the greater would be the amount of heat and light derived from the passage of the sunshine through it. In this way it might happen that the distant planets, having enormous atmospheres, may be better lighted up and warmed than we have been in the habit of regarding them. It is difficult to conceive, moreover, that orbital velocity is not productive of some amount of heat in our atmosphere by friction; and this in the larger orbits, where the rate of the planet is higher, must be greater in amount, and proportionate to the speed and size of the moving object. If the carbonic acid has been consolidated out of our atmosphere, oxygen has been extracted also; and if we are to regard the bulk of our atmosphere as diminished by the chemical combinations of its gases with terrestrial solids during the progress of vast ages, we may regard this diminution of its bulk as gigantic,—perhaps as fully a half-part since the commencement of the Palæozoic period.

By these remarks we are not ignoring the sagacity of Mr. Sterry Hunt's suggestions; they are very valuable and in the right direction. Our object is to submit that there may be cosmical reasons for great changes of climatal temperature, and others besides those we have hinted at; but it would be futile to look to cosmical causes unless we were prepared to admit the wonderful remoteness of the early periods geology has made known to us,—but which, after all, are only on the very threshold and entrance of the research into the great past existence of our planet that went before the earliest traces of its history our science has yet detected.

Some day we shall inquire what foundation there really is for the supposed former higher temperature of our earth at all? Perhaps we shall not find as much reason for the doctrine as some people suppose.

THREE DAYS AT FARRINGDON.—POSITION OF SPONGE-GRAVEL.

By C. J. A. Meyer.

Early in September of the present year, I accompanied my friend Mr. C. Evans in a short excursion to Farringdon, with a view to examining the well-known "Sponge-gravel" pits of Little Coxwell;

our intentions being, besides collecting fossils, to trace, if possible, some positive connection, or otherwise, between these reputed Upper Cretaceous Sponge-gravels and the acknowledged *Lower Greensand* deposits of Furze Hill and Badbury Hill.

Taking up our quarters at Farringdon, we first visited the Sponge-gravel pit near the Windmill public-house at Little Coxwell, where we found a splendid section of the gravel exposed (see section 4), and in a few hours had collected a good supply of fossils;—dip of beds E. by N. 10°, resting, in part at least, upon Kimmeridge clay. Next day we went to Furze Hill, and found near the top of the hill the ironstone concretions described by Mr. Godwin-Austen (Quar. Journ. Geol. Soc., vol. vi. p. 456), containing numerous fossils, all of them, I believe, of Lower Greensand age. These concretions, for the most part, lie scattered about on or near the surface. In one place, however, we found a small section exposed, where the concretions occurred in position, imbedded in light-coloured sand. About fifteen feet lower down the hill, we found the same light-coloured sand, alternating with clay in thin layers, without concretions, and apparently unfossiliferous.

In returning towards Farringdon by a pathway across some fields, and when about a mile east of Little Coxwell, we came to a gravel-pit of large size, the gravel of which struck us at once as being unlike that of the Windmill pit, the colour being very much darker, and the composition of the beds somewhat different. And here we presently observed an interesting fact, which seems to have hitherto escaped notice, viz. that this dark-coloured gravel (which, from its appearance, I shall call "red-gravel") *rests unconformably upon* the light-coloured "Sponge-gravel" of the Windmill pit,—the Sponge-gravel, as before observed, dipping E. by N., the Red-gravel W. by S. at a slight angle, the line between the two beds being sharply defined. The section exposed in the deepest part of the pit gave a thickness of about twenty feet to the Red-gravel, with the addition of six feet of Sponge-gravel (visible) beneath (see section 3). The composition of the Red-gravel we found to differ from that of the Sponge-gravel, in the scarcity of Sponges and the greater comparative abundance of Bryozoa.

As this pit (which, for distinction, I shall call East pit) is scarcely half a mile distant from the Windmill pit, both of them being on much the same level,—occupying, in fact, opposite sides of a flattened ridge of ground which extends from Furze Hill towards Farringdon, —a cross section between the two pits must be somewhat as is shown in the section, Pl. I. Fig. 1:—

Our next excursion was to Badbury Hill. In a small pit near the roadside, on the west slope of the hill, and at about fifty feet from the top, we found a section exposed, which was to me by far the most interesting one I had yet seen. This section was as follows:—

+ Light-coloured and ferruginous sand, with slabs and fragments of chert, apparently the débris of higher beds . . . . . . 14 feet.

a. Fine ash-coloured sand, *regularly stratified*, very like the sands with clay beneath the ironstone of Furze Hill . . . . . . 4 feet.
b. Dark-brown and ferruginous sand, with a mixture of small pebbles, Bryozoa, Terebratulæ, etc., regularly stratified . . . . . . 4 feet.
c. Ditto, ditto, with two or more bands of hard calcareous concretions, each about eight inches in thickness . . . . 5 feet.

This last was the lowest stratum exposed, but, from the appearance of the soil, the pebbly sands extended somewhat lower.

In the looser materials composing the strata *b*, *c*, we immediately recognized the upper portion of the Red-gravel of East pit, containing here, as there, *Rhynchonella nuciformis* in abundance, *R. latissima*, *R. depressa*, *Terebratella Menardi*, *Terebratula Tornacensis*, *T. depressa*, more rarely; and, in addition, a few specimens of *Terebratella oblonga*, Sow.

In the intermediate stone-beds, *c*, *T. oblonga* was not uncommon, associated more rarely with *R. depressa*, *T. Menardi*, *T. depressa*, and *T. Robertoni*, D'Arch. The stone also contained *Avicula Rauliniana*, D'Orb., *Pecten Rauliniana*, D'Orb., *P. orbicularis*, *Exogyra conica*, var., and *E. haliotoidea*,—shells which occur in the "Bargate Stone" and "Pebble-beds" of Godalming. In fact, except for the greater abundance of organic remains, this section agrees precisely with a section exposed in a quarry of the Lower Greensand near St. Katherine's Chapel, Guildford, where "pebble-beds" alternate, for a thickness of twenty feet or more, with layers of the "Bargate stone."

I was greatly pleased at finding *Terebratella oblonga* here in such comparative abundance, associated with *T. Menardi*, etc., as I had only met with a single specimen in the Sponge-gravel. Yet, what seemed to me to be of greater interest in this Badbury Hill section was the *upward* passage of the dark-coloured pebbly strata *b* (Red-gravel) into *a*,—thus, as it were, limiting the position of the Sponge-gravels within a definite vertical range; the fine sandy strata, *a*, underlying the ferruginous sands with chert and ironstone as well here as at Furze Hill and Farringdon Clump.

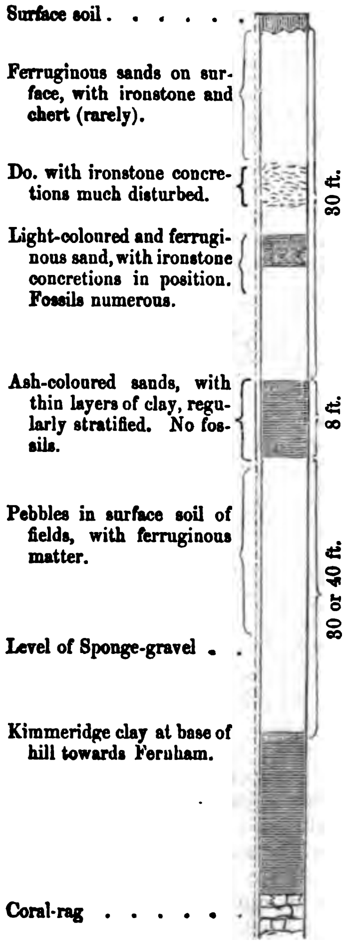
Our time being limited, we now returned towards Farringdon, revisiting the pits at Little Coxwell, and again examining the junction of the Sponge and Red-gravels in East pit.

From what I have now seen of the several sections in the neighbourhood, I can form but one opinion as to the position of the Sponge-gravels with relation to the surrounding deposits, viz. that the true "Sponge-gravel" of the Windmill-pit is unquestionably *the oldest of the Cretaceous deposits near Farringdon*, the strata exposed in the sections at East Pit and Badbury Hill (see sections 2, 3), forming, as nearly as possible, a continuous series; while at the same time there is no reason to doubt that the fossiliferous concretions capping Furze Hill are identical with the ironstone concretions which occur near the top of Badbury Hill, intermingled, here and there, with the cherty fragments. In offering so strong an opinion on this subject, I am, however, willing to confess, that had I not seen *the actual junc-*

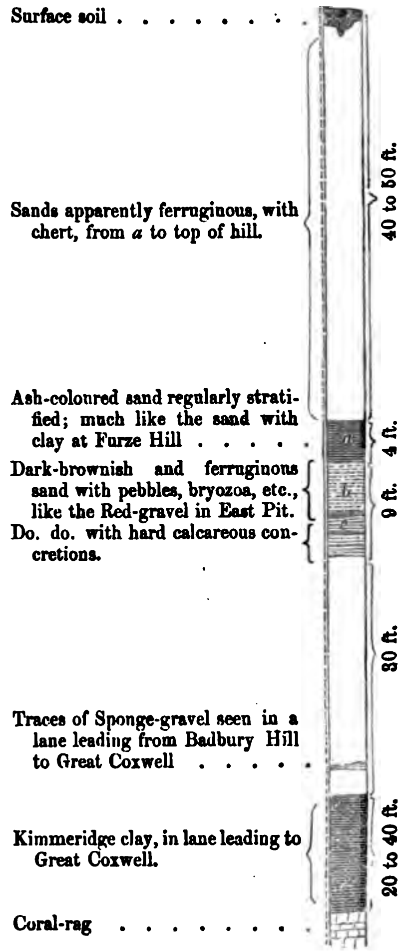
tion of the Sponge and Red gravels in East pit, and again met with the Red-gravel, in a slightly different form, near the top of Badbury Hill, I should not have ventured to assign any positive position to the true Sponge-gravel.

By what I gather from Mr. Sharpe's memoir 'On the Age of the Fossiliferous Sands and Gravels of Farringdon and its Neighbourhood' (Quar. Jour. Geol. Soc., vol. x. p. 176), the author of that paper was not aware of any real difference between the *Red* and the *Sponge-gravels*, and certainly not that they were distinct deposits, as is no doubt the case; nor does he seem to have himself examined the

1. Section at Furze Hill.



2. Section at Badbury Hill.



3. Section at East Pit, Little Coxwell.

Surface soil . . . . .

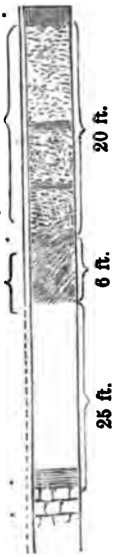
Red gravel—a dark ferruginous deposit composed principally of minute subangular pebbles and coarse sand, mixed with terebratula, bryozoa, etc., and *few* sponges.

Junction of Red and Sponge-gravels . . . . .

Sponge-gravel as in Windmill Pit. Sponges abundant.

Kimmeridge clay ? . . .

Coral-rag . . . . .



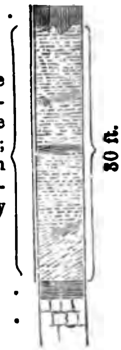
4. Section at Windmill Pit, Little Coxwell.

Surface soil . . . . .

Sponge-gravel—a mixture of shells, sponges, bryozoa, etc., with but little sand and few pebbles; the whole mass of a rich cream or light ferruginous colour, regularly stratified.

Kimmeridge clay . . . .

Coral-rag . . . . . .



These sections are intended to exhibit the Farringdon deposits in their relative position; the measurements in those portions of the sections noted as *obscure* by the dotted line at the sides of the woodcuts must, however, be taken as merely approximate, as we had no means of ascertaining their real thickness.

section at Badbury Hill. Had he done so, he must have noticed the fact that the same forms of Brachiopoda, with the addition of *T. oblonga*, and the same species of Bryozoa occur there which are found in the Red-gravel of East pit; and noticing this, he could hardly have separated the "Sponge-gravels" so entirely from all the surrounding deposits as he ultimately appears to have done. In one very important particular Mr. Sharpe is surely wrong. In page 178 of the above-mentioned memoir, he describes the ironstone deposits of Furze Hill, and the Sponge-gravels, as forming "*two deposits on the same level, abutting against one another.*" Now my impression is that the lower layers of the ironstone of Furze Hill, where in position, are decidedly above the level even of the higher portion of the Sponge gravel; and I was at first somewhat at a loss to account for the fact, supposing that the ash-coloured sands which we found to underlie the ironstone on Furze Hill, formed a portion of the Kimmeridge clay, and not, as we afterwards found in the Badbury Hill section, a deposit resting upon the Red-gravel.

The accompanying sections, compiled, with Mr. Evans's assistance, from notes taken on the spot, the parts margined by the double lines being from exposed vertical sections, will show more fully my idea of the position of the various deposits; and it follows that if these views as to the position of the "Sponge-gravel" are correct, the question as to its age can hardly remain doubtful, all the authorities agreeing that the fossiliferous ironstone concretions of Furze Hill are unquestionably *Lower Greensand*. Even, however, were this not the case, I should have no hesitation in comparing the Red-gravel of the Badbury Hill section with the Lower Greensand "Pebble-beds" of the St. Katherine's Hill quarry, near Guildford, so very striking is the resemblance between the two deposits.

And it is no new idea thus to compare the Farringdon deposits to the sands and gravels of Devizes, Calne, etc., nor even to the pebble-beds of the L. G. S. of Surrey. In June, 1850, Mr. W. Cunnington called attention to the occurrence of most of the Farringdon Brachiopoda in the Lower Greensand of Seend, near Devizes (Quar. Jour. Geol. Soc. vol. vi. p. 453). Mr. Godwin-Austen repeatedly refers to these deposits as being of similar age (Quar. Jour. Geol. Soc. vol. vi. p. 455; and vol. xii. p. 69); and Mr. Sharpe himself admits the fact of their accordance to each other. In comparing these deposits, however, it is necessary to distinguish between the *two* gravel-beds of Farringdon, and this does not appear to have been hitherto done; for it is the Red-gravel, containing, as it does, nearly all the Brachiopoda which occur in the lower deposit, but very few of the Sponges, that has been met with at Seend, and *not* the Sponge-gravel; and it is the Red-gravel which accords best with the Lower Greensand "pebble-beds" of Surrey.

LIST OF BRACHIOPODA FROM FARRINGDON.

	Sponge Gravel, Windmill Pit.	Red Gravel of East Pit.	Red Gravel of Badbury Pit.	Bargate Stone of Godalming.	Pebble-beds of Godalming.	Lower Greensand, Shanklin.	Gault, Upper Greensand or Chalk of England.
	1	2	3	4	5	6	7
Lingula truncata, *Sow.*	×	...	...	...	...	× × ×	...
Thecidium Wetherellii, *Morris*	×	...	...	...	...	...	×
Terebratella Menardi, *Lam.*	× × ×	×	× ×	×	×	...	×
T. oblonga, *Sow.*	×	...	× ×	× ×	× × ×	...	× ?
Terebratula biplicata, *Brocchii*	× ?	...	...	...	...	× ?	× × ×
T. sella, *Sow.*	× ?	...	...	...	...	× ×	× ?
T. tornacensis, *var.*, D'Archiac	× × ×	×	× ×	×	× ?	×	...
T. depressa, *Lam.*	× ×	×	×	...	× ?	·×	...
T. Robertoni, *D'Archiac*	×	× ?	× ?	× ?	× × ×?	× ?	...
T. tamarindus, *Sow.*	×	×	...	...	×	...	...
Rhynchonella latissima, *Sow.*	× ×	...	×	×	?	..	× ×
R. depressa, *Sow.*	× × ×	×	× ×	×	×	× ?	× ?
R. nuciformis, *Sow.*	× ×	× × ×	× ×	×	×	?	×
R. Gibbsiana, *Sow.*	×	...	...	...	×	× ×	...

N.B. × Denotes the occurrence of a species as *rare*.
× × As tolerably common.
× × × As abundant.

Although I have formed my *conclusions* as to the age of the Sponge-

Fig. 1.
SECTION FROM FURZE HILL TO FARRINGDON.—1. Red Gravel. 2. Sponge Gravel. 3. Kimmeridge Clay. 4. Coral Rag.

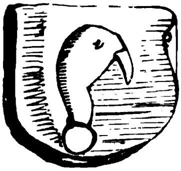


Fig. 2.

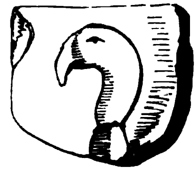


Fig. 3.

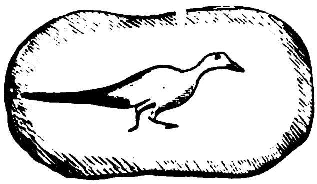


Fig. 8.

Fig. 4.

Fig. 6.

Fig. 5.

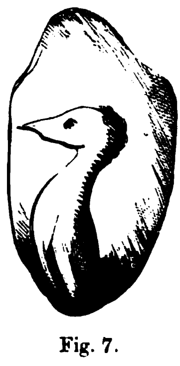


Fig. 7.

FOSSIL BIRDS.—Facsimiles from lesser Figs. 2, 3; from Kircher, Figs. 4 to 8.

gravels on geological rather than on palæontological evidence, the accompanying list of Farringdon Brachiopoda, from specimens which I have myself collected, may not be uninteresting. I regret that I cannot add a list of the small Bryozoa, etc., as several of the species are common alike to the Lower Greensand pebble-beds of Godalming and the Sponge-gravels.

In this Table, the columns 1, 2, 3 show the species of Brachiopoda met with by Mr. Evans and myself in our visit to the sponge-gravel pits. Col. 4, 5, 6, I have added, as showing instances of the occurrence of the same species in the Lower Greensand of Godalming and Shanklin, which have come under my own observation; and col. 7, as showing their recorded occurrence in British Cretaceous deposits of an age younger than that of the Lower Greensand. The absence in the Farringdon deposits of such *Upper Greensand* forms as *Terebratella pectita*, *Terebratulina striata*, *Kingena lima*, *T. ovata*, *T. biplicata*, *T. obtusa*, *Rhynchonella compressa*, *R. sulcata*, and *R. grasiana*, species which do not appear to be uncommon at Warminster and Cambridge, has long seemed to me to be a fact of much significance.

FOSSIL BIRDS.

By the Editor.

(*Continued from page* 455.)

Rozier says, in his 'Journal de Physique,' 1782, page 174, that "mention is made in the Catalogue of Davila of a tibia and of a beak imprinted on two different stones." If there be any other notice in Davila than the passages we have quoted, it has escaped our search.

In 1782, M. Robert de Paul de Lamanon gave, in the Abbé Rozier's 'Journal de Physique' (vol. xx. p. 174), an excellent summary of what was then known of Ornithic fossils. After noticing the accounts in Albertus Magnus and other old authors, he goes on to say in his 'Description de Divers Fossiles trouvés dans les carrières de Montmartre, près Paris, et vues générales sur la formation des Pierres gypseuses,'* "M. Rouelle, according to M. Darcet, found in the plaster quarries of Montmartre parts of a bird separated one from the other. I (Lamanon) have seen also in the Cabinet of Natural History of Bordeaux, some bones that it has been attempted to refer to birds; they were found by the Abbé Desbiey in the quarries of Léognan, which are at two leagues from this capital. We can only assert, however, that these isolated bones *may* have belonged to birds, on the ground that their medullary cavity is very large relatively to their thickness. No anatomist has determined what is the relation of this cavity to the osseous portion in the different classes of animals; it is even probable one could not establish any general rule

* In the Abbé Rozier's 'Journal de Physique,' March, 1782, p. 174 *et seq.*

in this respect, and that certain aquatic animals have bones as light and as delicate (déliés) as many birds. As to this, which has the beaks separated from the body, it is very easy to be deceived; and we know that the beaks of birds, as they were for a long time believed to be, in grey amber, have been recognized as the beaks of a cuttle-fish (sèche) or a calmar, since they have been better examined.

"But eliminating all that authors have so assigned through heightened imagination, there remain some facts about which no legitimate doubt is permissible, since the fine discovery that has been made of which I have to render an account. On the 2nd November of the past year (1781), M. Darcet made a lithological journey to Montmartre, and found in the hands of the workmen who worked at the plaster-quarries (plâtrières) a petrified bird, in the most beautiful conservation. We should not, perhaps, have had for a long time the complete proof of the existence of ornitholites, if this *savant* had not been that day at Montmartre, for the workmen destroy what they find, or sell to the first comer; and thus it is so much is lost to the progress of Natural History. M. Darcet is engaged at this time in important chemical labours, and has very kindly confided this petrifaction to me, and requested me to describe it.

"The cliff (butte) of Montmartre is elevated about 40 toises above the level of the Seine at Paris; the gypsum rock, of which it is chiefly composed, is there arranged in beds more or less distinct, more or less adherent one to another. We see at the line of their contact a band, which seems to contain a slightly ferruginous matter. If we separate these from each other, and observe their surfaces, we find them less brilliant (brillantes) than the interior of the stone; they are also of a lighter tint of red. Powder is used in working the quarries and to obtain the blocks, which are afterwards broken by blows of the hammer; it was in the interior of the stone, at more than 20 toises from the summit, and between two adherent beds (deux couches qui avoient entr'elles de l'adhérence) that the bird in question was found. The greatest part of its substance has followed the upper bed, and one sees the rest with the imprint of the whole in the lower bed. It is posed (posé) on its side; one of its wings extended, the other folded (repliée); the head is turned in such a manner that we see one eye, the under-part (dessous) of the beak and a part of the upper (dessus). Its position (situation) is natural, and there is not any transposition in the parts. It appears, then, that it has not been embedded (enseveli) alive, and that it did not perish in a catastrophe (dont ses ailes n'auroient pu le garantir), but that it fell at the bottom of tranquil water, which deposited in course of time the beds above it."*

As yet, however, bird-remains had been but little collected, and we find the celebrated Peter Camper, the discoverer of the famous *Mosasaurus*, of Maestricht, in a letter printed in the "Philosophical

* Further details from Rozier and the figure from his Plate will be given in the stratigraphical considerations with the other gypsum fossils.

Transactions"* for 1786, writing about them in a very doubtful manner:—

"Dr. Michaels wrote me some time ago that the above-mentioned fragment in Mr. J. Hunter's collection belonged to a bird, which I could hardly believe, as I never had seen in any collection whatsoever, either in London, Paris, Brussels, Göttingen, Cassel, Brunswick, Hanover, or Berlin, nor in my own country, any fossil bone belonging to a bird. I know there is a small one described in the Abbé Rozier's 'Journal de Physique' for March, 1782, which is at present in the collection of M. d'Arcet, at Paris. I expect also from Montmartre a small leg of a petrified bird, but these are the only ones I have ever heard of; those of Stonefield, near Woodstock, being undoubtedly fishes. I think it is a curious circumstance worthy the attention of the curious, that no human bones, and of birds but very few, have hitherto been found in a petrified state belonging to the Old World."

Having now run through the more or less doubtful and apocryphal statements of the early naturalists and geologists, we may attempt to follow out a stratigraphical arrangement of the remainder of the mass of materials before us, giving the various discoveries and accounts at the same time as nearly as may in their proper sequence, and reserving for our concluding summary the comments, and any disputations of the ordinarily received opinions of geologists. We then take here the supposed earliest geological traces of birds; the footprints in the so-called Connecticut New Red Sandstone. We leave for the present the dispute as to the Trias being the correct period to which to assign those strata, for even if these Red Sandstone beds should really belong to the Jurassic series, the footprints they contain would still be the earliest traces of ornithic life we as yet possess.

The first specimen of the footmarks in the valley of the Connecticut river was ploughed up in South Hadley in 1802, by Pliny Moody, Esq., then a boy, before he went to college. This specimen, containing a row of fine tracks, was purchased by Dr. Dwight, of South Hadley, and is now in the Appleton Ichnological Cabinet (No. 16/2). So strikingly did these tracks resemble those of birds that they were familiarly spoken of as the tracks of "poultry" or of "Noah's Raven."†

It was not, however, until 1836, that any attempt was made to describe these tracks scientifically. The year previous some flagstones were obtained in Montague for the streets in Greenfield, by

* Phil. Trans., vol. lxxvi., 1786, p. 451.

† Mr. Dexter Marsh, however, in a letter to Professor Silliman, in 1848, says, "You will recollect that the first specimen of fossil footprints of birds ever brought into public notice in this country (United States) was the slab I discovered among the flagging-stone, while laying the flagging-stone near my house, which Dr. Deane first described to President Hitchcock as the *footprints of birds*,"—from which statement it would seem that Mr. Marsh claims to be the first to notice these impressions, and Professor Hitchcock adds, in conversation with Mr. Wilson, "I understood him to claim the discovery." (Amer. Journal Science, vol. vi. new ser. p. 272.)

Mr. William Wilson, who observed impressions upon them, which he regarded as those of the "turkey tribe." They (*Tridentipes elegans*) were observed by the late Dr. James Deane, who sent casts of them to Professor Hitchcock, secured them for his cabinet and gave it as his opinion, from their form and succession, that they were made by birds. After visiting all the quarries, and discovering other and larger specimens, Professor Hitchcock gave a scientific description of seven species in 1836 in the 'American Journal of Science.' With a few eminent exceptions—Silliman, Buckland, Rogers, Emmons, etc.—his views were not adopted by scientific men. He continued, however, to explore, and from time to time to describe new species until, within six years, during which he laboured almost alone, the number of species amounted to thirty-two; and a general acquiescence was secured for the views he had advanced. The following bibliography will show by whom, when, and where the tracks—birds' and other tracks—have been described up to 1858.*

BIBLIOGRAPHY OF CONNECTICUT FOOTPRINTS.

Ornithicnology; or, Description of the Footmarks of Birds (Ornithicnites) on New Red Sandstone in Massachusetts. By Professor Edward Hitchcock. In 'American Journal of Science,' vol. xxix. p. 307. January, 1836. 34 pages and 3 plates.

Ornithicnites in Connecticut. In 'American Journal of Science,' vol. xxxi. p. 174. January, 1837. By E. Hitchcock.

Ornithicnites in Connecticut. By Professor B. Silliman. Op. cit. p. 165.

Fossil Footsteps in Sandstone and Grauwacke, with a general table. By E. Hitchcock. In 'American Journal of Science,' vol. xxxii. p. 174. July, 1837.

Newly Discovered Ichnolites at Middletown, Connecticut. By W. C. Redfield. In 'American Journal of Science,' vol. xxxiii. p. 201. January, 1838.

Note to Professor Conrad's Remarks on *Ornithichnites*. By Professor B. Silliman. In 'American Journal of Science,' vol. xxxv. p. 246. January, 1839.

Final Report on the Geology of Massachusetts. By E. Hitchcock. 62 quarto pages and 22 plates devoted to the footmarks, and 27 species described. Amherst, 1841.

Report by Professor H. D. Rogers, Lardner Vanuxem, R. C. Taylor, E. Emmons, and T. H. Conrad, on the *Ornithicnites*, or Footmarks of Extinct Birds, in the New Red Sandstone of Massachusetts and Connecticut, observed and described by Professor Hitchcock, of Amherst. In 'American Journal of Science,' vol. xli. p. 165. October, 1841.

Five New Species of Fossil Footmarks. By E. Hitchcock. Described in 'Transactions of American Association of Geologists and Naturalists,' vol. i. p. 254. 1842. 11 pages and 1 plate.

New Species of Footmark, with Rain-marks from Portland, Connecticut. By W. C. Redfield. In 'American Journal of Science,' vol. xliii. p. 172. October, 1842.

* This account and the bibliography is taken in the main from Hitchcock's 'Report on the Sandstone of the Connecticut Valley, especially its Fowl Footmarks.' Boston, 1858.

Notice of Newly Discovered Fish-Beds and a Fossil Footmark in the Red Sandstone Formation of New Jersey. By W. M. C. Redfield. In 'American Journal of Science,' vol. xliv. p. 134. April, 1843.

On the Fossil *Footprints of Birds* and Impressions of Rain-drops in the Valley of the Connecticut. By Charles Lyell. In Quart. Journ. Geol. Soc. of London, vol. iii. no. 91. Also in 'American Journal of Science,' vol. xlv. p. 394.

Ornithichnites of the Connecticut River Sandstones and the Dinornis of New Zealand. By Professor B. Silliman. (Dr. Deane's correspondence with Dr. Mantell.) In 'American Journal of Science,' vol. xlv. p. 177. October, 1843.

On the Fossil Footmarks of Turner's Falls, Massachusetts. By James Deane, M.D. 5 pages and 2 plates. In 'American Journal of Science,' vol. xlvi. p. 73. April, 1844.

Report on Ichnolithology or Fossil Footmarks, with a Description of several New Species and the Coprolites of Birds from the Valley of the Connecticut River, and of a supposed Footmark from the Valley of the Hudson River. By E. Hitchcock. [Read before the Association of American Geologists and Naturalists at Washington, 11th May, 1844.] In 'American Journal of Science,' vol. xlvii. pp. 113 and 292. 32 pages and 2 plates.

On the Discovery of Fossil Footmarks. By James Deane, M.D. In 'American Journal of Science,' vol. xlvii. p. 381. 10 and 2 pages.

Rejoinder to the preceding Article. By E. Hitchcock. Op. cit. p. 390. 10 pages.

Answer to the Rejoinder of Professor Hitchcock. By J. Deane. Op. cit. p. 399. 10 and 3 pages.

Analysis of the Coprolites of Birds from the New Red Sandstone of the Connecticut. By Samuel L. Dana, LL.D. With remarks by E. Hitchcock. In 'American Journal of Science,' vol. xlviii. p. 46. 15 pages.

Extract of a Letter from Professor E. Hitchcock, embracing miscellaneous remarks upon Fossil Footmarks, etc., and a Letter from Professor Richard Owen, on the Great Bird-nests of New Holland. In 'American Journal of Science,' vol. xlviii. p. 61. April, 1845. 4 pages.

Description of Fossil Footprints in the New Red Sandstone of the Connecticut Valley. By James Deane, M.D. In 'American Journal of Science,' vol. xlviii. p. 158. April, 1845. 10 pages and 1 plate.

Fossil Footmarks found in the Strata of the Carboniferous Series in Westmoreland County, Pennsylvania. By Dr. T. A. King. In 'American Journal of Science,' vol. xlviii. pp. 217 and 343. April, 1845. 11 pages with woodcuts.

On the Fossil Footmarks in the Red Sandstone of the Connecticut River. By Dr. Joseph Barratt. Read before the Association of American Geologists and Naturalists at New Haven. Proceedings, p. 23. 1845.

On the Evidences of Congelation on the New Red Sandstone. By Dr. Barratt. Op. cit. p. 26. 1845.

An Attempt to Name, Classify, and Describe the Animals that made the Fossil Footmarks of New England. By E. Hitchcock. In Proceedings of the Association of American Geologists and Naturalists, p. 23. 1845.

Footsteps of the Sandpiper on Clay (with a plate). By Sir C. Lyell. In 'First Travels in United States,' vol. ii. pp. 134–143. 1845.

Supposed Reptilian Footsteps in Nova Scotia. By Sir C. Lyell. Op. cit. vol. ii. p. 176.

On the Fossil Footsteps of Birds on Connecticut River. By Sir C. Lyell. Op. cit. vol. i. p. 200.

Notice of a New Species of Batrachian Footmark. By James Deane, M.D. In 'American Journal of Science,' vol. xlix. p. 206.

Footprints. By Dr. J. A. King. In 'American Journal of Science,' vol. xlix. p. 206.

Fossil Footmarks and Raindrops. By James Deane, M.D. In 'American Journal of Science,' vol. xlix. p. 213. 3 pages.

Footprints in the Coal-rocks of Westmoreland County, Pennsylvania. By Dr. J. H. King. In 'American Journal of Science,' vol. i. new series, p. 268. May, 1846.

Notice of a Small Ornithicnite. By Professor C. B. Adams. In 'American Journal of Science,' vol. ii. new series, p. 215. November, 1846.

On the Evidence of Fossil Footprints of a Quadruped, allied to Cheirotherium, in the coal-strata of Pennsylvania. By Sir Charles Lyell. In 'American Journal of Science,' vol. iii. new series, p. 74. 6 pages. May, 1847.

Ornithicnites—Phalangial Impressions. By the Editors of 'American Journal of Science,' vol. iii. new series, p. 276.

Tracks of Alligators. Op. cit. p. 125. By the Editors.

Description of Two new species of Fossil Footmarks, found in Massachusetts and Connecticut, or of the Animals that made them. By E. Hitchcock. In 'American Journal of Science,' vol. iv. new series, p. 46. November, 1847. 12 pages, with 3 woodcuts.

Fossil Footprints—Reclamation. By Dr. J. Deane. In 'American Journal of Science,' vol. iv. new series, p. 448.

Fossil Footprint of a new species of Quadruped. By James Deane, M.D. In 'American Journal of Science,' vol. v. new series, p. 40. May, 1848. 1 page and a sketch.

Fossil Footprints. By Dexter Marsh. In 'American Journal of Science,' vol. vi. new series, p. 272. November, 1848. 3 pages and sketch.

The Fossil Footprints of the United States, and the Animals that made them. By E. Hitchcock. From the Transactions of the American Academy of Arts and Sciences, vol. iii. 128 pages, and 24 quarto plates, describing 52 species. 1849.

Notes on some recent Footprints on Red Mud, in Nova Scotia. Collected by W. B. Webster, of Kentville. By Sir Charles Lyell. In Proceedings of London Geological Society. February 21, 1849.

Illustrations of Fossil Footprints of the Valley of the Connecticut. By James Deane, M.D. In Transactions of American Academy of Arts and Sciences, vol. iv. 16 pages and 9 quarto plates. 1849.

Footprints in the Coal-strata of Pennsylvania. By Sir Charles Lyell. 10 pages and 3 figures. In 'Second Travels in the United States,' vol. ii. p. 228. 1849.

On the Fossil Footmarks of the Red Sandstone of Pottsville. By Isaac Lea. From Transactions of American Philosophical Society, 'American Journal of Science,' vol. xiv. new series, p. 457.

Pennsylvania. By Professor H. D. Rogers. In 'Annual of Scientific Discovery,' 1851, p. 314.

On the Foot-tracks in the Potsdam Sandstone of Lower Canada. By Sir William Logan. In "Report on the Canadian Survey," 1851–2. 'Annual of Scientific Discovery,' 1853, p. 304.

On the Tracks of Gasteropoda, Crustacea, etc., in the Clinton group of New York. By Professor James Hall. In 'Palæontology of New York,' vol. ii. p. 26. 1852. 11 pages, 7 quarto plates.

Remarks on the Fossil Impressions in the Sandstone Rocks of Connecticut River. By Professor John C. Warren, M.D. 1 vol. of 54 pages and 1 plate. 1854.
On the Footprints occurring in the Pottsdam Sandstone of Canada. By W. E. Logan, Esq. In 'Quarterly Journal of Geological Society,' 1852. p. 199.
Description of the Impressions of Footprints of the Prototichnites, from the Pottsdam Sandstone of Canada. By Professor R. Owen, F.R.S. In 'Quarterly Journal of Geological Society,' 1852, p. 214, with 10 plates.
On recent Bird-tracks on the Sand of the Bay of Fundy. By J. L. Hayes. In 'Annual of Scientific Discovery' for 1851, p. 314.
On the Reptilian Footprints in the Carboniferous Rocks of Eastern America; Impressions (chiefly Tracks) on Alluvial Clay in Hadley, Massachusetts. By Charles H. Hitchcock. In 'American Journal of Science,' May, 1855. 5 pages.
Fossil Footmarks on the Red Sandstone of Pottsville, Pennsylvania. By Isaac Lea. 16 pages super-royal folio, with 1 double lithographic plate. 1855.
On a Few Fossil Footprints (*Gigandipus caudatus*). By Edward Hitchcock. In 'American Journal of Science,' new series, vol. xxi. p. 96. 3 pages and a sketch. January, 1856.
On New and Remarkable Gigantic Fossils and Footmarks. By John C. Warren, M.D. Read before the Boston Society of Natural History, January, 1856. In 'Boston Daily Traveller,' January 24th, 1856.
Additional Facts respecting the Tracts of *Otozoum Moodii* on the Liassic Sandstone of the Connecticut Valley. By Edward Hitchcock. In Proceedings of American Scientific Association, 1856, p. 228.
On the Sandstone Fossils of Connecticut River. By James Deane, M.D. 6 quarto pages, with 3 plates. In 'Journal of the Academy of Natural Science,' second series, vol. iii. March, 1856.
Connection of Fossil Footprints with the Theory of Progressive Development. By Professor H. D. Rogers. In 'Annual of Scientific Discovery,' 1856, p. 314.
Fossil Footprints. By Professor J. Wyman. Discovered by Professor H. D. Rogers, in Carboniferous strata, Pennsylvania. In Proceedings of Boston Society of Natural History, vol. v. p. 258. 'American Journal of Science,' vol. xxi. new series, p. 441. May, 1856.
Notice of *Chelichnus Wymanianus*. By Isaac Lea. In 'American Journal of Science,' vol. xxii. new series, p. 123. July, 1856.
Ichnology of New England. A Report on the Sandstone of the Connecticut Valley, especially its Fossil Footmarks, made to the Government of Massachusetts. By Edward Hitchcock. 1 vol. quarto, of 232 pages, with 60 plates, illustrating one hundred and nineteen species of the Connecticut Valley, 1858.

It would interfere with our plan, however, to enter here into details of these footprints, and we shall therefore pass on to the first notice of the actual remains of birds in this formation, reserving hereafter a chapter especially devoted to Ornithictites, and the evidence they afford of the classes of birds or animals that made them. This occurs in Mr. E. Emmons's 'American Geology,' part vi., published at Albany, N. Y., in 1857, where at page 148 is the following description:—

"AVES, or Birds.—*Palæornis Struthionoides*, n. g. (E.). It is a remarkable fact that the remains of birds are so rare in the sandstones and shales in which their footprints are so common. The only fragment of a bone which has been obtained in the country, which could be referred to this class of warm-blooded animals, I procured from the red and variegated sandstones of Anson County, N. C. It is a portion of the sacrum (fig. 114), natural size, and contains six vertebræ anchylosed together. The figure shows the under side, and brings to view their perfect confluence. Upon the sides these bodies are seen projecting laterally from the mass of bone. It is three and one-half inches long, one and six-tenth inches wide, and one and two-tenth inches thick. (See Pl. IV.)

"A microscopic examination of the bone-cells (fig. 115) confirms the opinion expressed relative to the class of animals to which it belongs. 1, shows the bone-cells of a fish; 2, those of a reptile; and the remaining five the cells of the bone under consideration. The size of this bone proves that it belonged to a large heavy bird. The width of the same bone in the eagle is half an inch. It is more than three times the size of the largest of the kind, but it is not the proper bird with which to compare it, for it is highly probable that it more resembled the *Struthiones*, or ostriches,—birds with thick toes,—than any other living family. Its specific name has an allusion to this resemblance. The footprints of birds are mostly made by those which possessed toes of this description, especially those which are confined to the sandstone of the valley of the Connecticut."

The first notice of bird remains in the Oolite of England was given in the 'Quarterly Journal of the Microscopical Society of London,' 1857, vol. v. p. 63, in an article, illustrated with plates, "On the Existence of BIRDS during the deposition of the STONESFIELD SLATE, proved by a comparison of the MICROSCOPIC STRUCTURE of certain BONES of that Formation with those of RECENT BONES. By the Rev. J. B. P. Dennis, F.G.S., of Bury St. Edmund's."

From extensive observations made upon the bones of birds, Mr. Dennis found that in their microscopic characters, these bones are as distinct from those of mammifers as the latter are from the bones of saurians. "As the lacuna in the saurian bone exceeds that of the mammal in the size of its canaliculi, so does the latter exceed that of the bird; and as they are more numerous and more branched in the bird than in the mammal, so, in like manner, are they more so in mammalian than in saurian bone." "It is in birds," he continues, "that the Haversian tubes attain their most elegant and varied reticulations, not fortuitously, but with design, and that intimately connected with the life and habits of the animal. In fact, each bone is a study in itself, and involves a knowledge of the muscles that move it, as well as of the use it is designed for."

The object of his paper, Mr. Dennis says, "is to prove, from a general exposition of the structure of birds, that they had representatives on this planet when the Stonesfield Slate was still the soft mud of a large estuary;" and for this purpose he enters (for the thorough

Fig. 1.

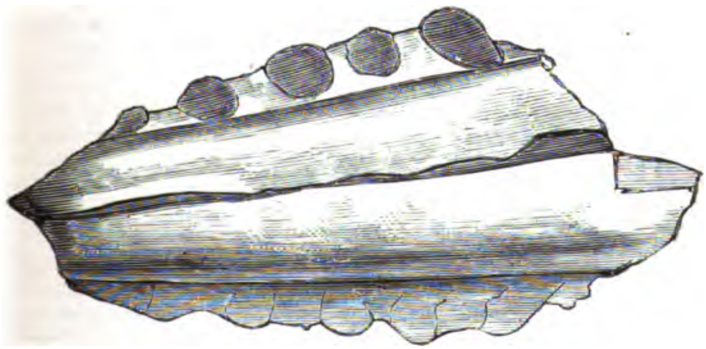


Fig. 2.

FIGURES OF FOSSIL BIRDS, FROM CUVIER (Fig. 1) AND EMMONS (Fig. 2).

elucidation of the question) into the consideration of the structure, not only of birds but of both mammals and reptiles also, the latter, by the Pterodactyles, being intimately connected with the subject.

"Amongst mammifers, the bats alone have the power of maintaining a continued flight, by the rapid vibrations of membranous wings, which are in fact but a modification of the arm and hand, so adapted as to enable them to extend a thin canvas by which their bodies are drawn through the air. To this end the fingers are greatly increased in length as well as the humerus and radius; the scapula also is large, and lengthened in a slanting direction at its lower portion for the better attachment of muscular power; and to afford greater support to the stroke of the wing; the clavicles are curved like the furcula of the bird, and perform the united functions of the furcula and coracoids, preventing the compression of the chest, and keeping the humerus in its place when acted upon by the pectoral muscles. . . . But there is no deviation in this flying mammal from the plan nature has laid down for the construction of mammifers; the bat, because it flies, is not a bird, no more than the bird that swims and cannot fly is a fish. . . . The wing of the bat is in accordance with the same design that framed the hand of man. . . . The bones of bats are excessively strong, hard, and semitransparent. . . . The muscles of the fore arm are extremely insignificant when compared with those of birds; their bones are harder in texture, and only the very large bats possess Haversian tubes, even the largest indigenous to this country are without them; * and the Pteropus, the largest of the family, has only short and straight ones, and these not at all numerous. . . . In fig. 1, pl. vi. are shown the Haversian tubes and lacunæ of the Pteropus or flying fox, as it is popularly called; the Haversian tubes are more like long lacunæ, and are in the humerus straight, unconnected, and not numerous, but the lacunæ are very abundant; these become more fusiform in the phalanges (fig. 2). . . . The canaliculi of the bat are large for mammals. . . . I conceive the reason of the paucity or absence of these tubes (the Haversian) in the bats is to be found in the character of their wings, and the habits of the animal. Bats require light but strong bones, hardly at all flexible, for were they so the great length and slenderness would make the wing so pliable that it would be powerless in resisting the air, and thereby enabling the animal to sustain itself in flight. Lightness is obtained by numerous lacunæ, and numerous and comparatively thick canaliculi, and no more elasticity is imparted to the bone than is sufficient to preserve its structure, and obviate any fracture in flight. In the bird, on the contrary, elastic resistance to muscular pressure is of much importance; and hence appears to have arisen that admirable application and adjustment of the Haversian tubes so conspicuous in the economy of birds. . . . Besides bats there are other mammifers, such as the Galeopithecus, flying Phalangers, etc., which . . . are enabled to perform flights to some extent by the aid of a lateral extension of their skin, which being spread out like a parachute sustains them for some time. . . . In the smaller flying Phalanger the Haversian tubes, especially in the tibia, are large and numerous, the lacunæ are very numerous, and the canaliculi large; every particle of unnecessary weight seems to have been abstracted from their bones, that the light animal may float almost like a feather in the air (fig. 3). . . .

"Amongst recent reptiles, the *Draco volans* is enabled, by an extension of

* In a footnote Mr. Dennis states that he has "found them in the jaw, a thick stem with a few straight branches between the fangs of the teeth."

its false ribs, to expand a fan-like membrane, by which it can . . . for a little time sustain itself in the air. . . . The bones of this most interesting reptile are hollow and thin, but strong, without Haversian tubes, and having numerous lacunæ; the canaliculi are fine for a reptile, but partake in other respects of the reptilian characters. . . . The gannet, being peculiarly characterized by the length of its wing-bones, is a very appropriate bird to compare both with the bats and the Pterodactyles; . . . the humerus, radius, and ulna partake of the (microscopic) characters observed in all birds whose wings are long and pointed. In the humerus vertical section (fig. 17) the Haversian tubes do not reticulate, but run nearly parallel, and ultimately converging to a point, from which extends another tube, which converges in a similar manner. . . . In the transverse section the Haversian tubes appear as round dots, the lacunæ as small irregular specks, and the canaliculi beautifully reticulate, etc. . . . Furcula, fig. 18, coracoid, fig. 19, femur, fig. 20; transverse section, fig. 21; tibia, fig. 22, rib, fig. 24; furcula of swift, fig. 6. . . . The structure of the gannet . . . in the principal bones admirably exhibits the beautiful adaptation of the microscopic structure of bone to the movements, habits, and well-being of the creature; and in no bone is that adaptation more closely shown than in the coracoid—the circular reticulations of the Haversian canals in which bone are assuredly designed to enable it to sustain the shock it must receive when the bird impinges on the water. . . .

" For ordinary purposes, the gelatinous homogeneous bones of fishes seem sufficiently strong for their mode of living, but a much more elaborate structure is requisite in the higher vertebrata. . . . In the *Ichthyosaurus* and *Plesiosaurus*, the canaliculi, though finer than those of some other saurians, are few in number; hence their bones are perfectly distinct from those of mammifers or birds."

Mr. Dennis then passes on to the more direct consideration of the structure of birds' bones:—

" Comparisons," he says, " with the same bones in birds of similar flight and configuration of the wing are highly useful in elucidating this subject. Take, for instance, such birds as the ring-dotterel; turnstone, dunlin, pigmy curlew, little stint, and other birds of that description, whose mode of flight is so similar that . . . the most practised sportsman 'cannot' distinguish one from the other by its flight. If we examine a portion of the ulna taken from the same part of the bone in any one or all of these birds, we shall at once observe a similar and singular correspondence in the disposition of the Haversian tubes. Examine next the ulna of the greensand piper, a bird whose wing is broader . . . and not so pointed, . . . and whose flight is easily recognized from its congeners, . . . and there is 'an entirely different arrangement of the Haversian tubes, which are reticulated in every direction, while in the rest they observe longitudinal directions."

What conclusion can we arrive at, Mr. Dennis asks, but that these tubes are arranged in accordance with the flight of birds? and in confirmation of this view he points out that the starling, raven, jay, etc., in which the secondary quills are well developed, have all fine and numerous reticulated tubes:—

" In the fowl they are very powerful, and the ulna contains numerous and fine tubes; in the owls the same; in the hawks the Haversian tubes are large and much reticulated, and are easily recognized from those of other birds. It seems therefore possible, from the microscopic structure of the bone of a bird, to divine the shape of its wing and the character of its flight, there being a perfect correspondence one with the other, just as a perfect knowledge of the femur will inform us whether a bird could swim, or only ran or walked."

And this, he thinks, may be done even from a fragment of a bone, "after we have acquainted ourselves with the general principles by very numerous and exact observations."

"In the coracoid, for instance, the ordinary disposition of the Haversian tubes would be longitudinal, braced more or less, because that would be the best arrangement to resist the powerful action of the pectoral muscles. . . . The ulna of the razor-bird and guillemot is more reticulated than would primarily be expected in the wing of a bird when the secondary quills are so very weak; but then it must be considered that those birds use their wings much more like fins when under water than as instruments of flight," etc.

Having so far grappled with the general features of the microscopic characters of birds, Mr. Dennis takes up the microscopic structure of Pterodactyles. It must not, however, be forgotten that we are quoting an author who was amongst the first to investigate the subject, and whose painstaking and details are therefore the more worthy of credit to himself, and useful to the student, from their elaborate minuteness.

"The *Pterodactylus longirostris* perhaps affords us the most perfect means of studying the singular proportions of its skeleton. A larger and less perfect, but exceedingly useful one was discovered by Miss Anning, at Lyme Regis, . . . now in the British Museum. Also portions of the jaws of a very large kind have been discovered in our Chalk formation, with other bones, now supposed to have belonged to a similar animal. From these specimens we learn that the animal was a true Saurian, apparently adapted for flight and for arboreal and terrestrial movements, and instead of possessing, like the bat, an extension of all the fingers, it had only one prolonged, the others being used in progression. . . . We may suppose that the Pterodactyle in some degree in the use of its limbs approached the frog; we may also . . . that the muscular development of the fore arm of the Pterodactyle was something between that of the bat, frog, and bird. The presence of quills in the bird has evidently materially affected the muscular development of the fore-arm; as also their being bipeds involved a greater development of the muscles of the leg. . . . In the Pterodactyle the strain upon the bones of the wing would be principally in the long direction, there being no lateral pressure from feathers being attached to the bone. In the bird . . . the Haversian tubes vary according to the shape and uses of the wing, but there is no reason to suppose that such variations would be required in the Pterodactyle. In the Phalangers they extend longitudinally; we may therefore suppose that such was the case in the Pterodactyle. . . .

"Next, with regard to the lacunæ, of what shape would analogy teach us to expect them to be in the Pterodactyle? Surely long pointed ovals; as, indeed, they have been so figured, only the mistake made was in supposing such a shape was peculiarly characteristic of the Pterodactyle, whereas the shape of the lacuna is characteristic of no class or order of vertebrate animals,

but is only connected with the requirements of the bones of the animal, and may be long or round in the same animal as occasion requires."

After writing the above remarks, Mr. Dennis received from Mr. Henry Catt a portion of bone from the chalk of Brighton, which exhibited precisely these characters. Writing of it, he says:—

"The Haversian tubes are principally longitudinal; the lacunæ are long, like those on the bill of the pelican,—and, indeed, the Haversian tubes may nearly compare, especially in size. There is, however, a peculiarity I was not prepared for, having observed it in no bird-bones, though I have noticed something like it in the frog. It is the way in which the lacunæ cross.* There appears to be a set running longitudinally, and a set above them running in the opposite direction, which gives a very *marked and peculiar character* to the bone, and makes me think the bone from the Chalk, and which is a hollow bone with very thin walls of a peculiar texture,† is Pterodactyle bone. Another thing confirms me in this view: the canaliculi are not numerous, like those of birds (fig. 7 and 14); if so, this is a further confirmation of those general principles I laid down in a previous paper on the characteristics of bone,—the Pterodactyle, though it could fly like the bird or bat, yet showing its saurian characters, both outwardly and inwardly in its bones."

Mr. Dennis then takes up that topic with which we are now most interested,—a bone from the Stonesfield slate, which he assigns to the class of birds. The fossil bone which Mr. Dennis submitted to examination was selected from several other supposed fossil bones of birds from that stratum, belonging to Mr. Adams, of Buriton, Petersfield. It was selected as one of the greatest interest, from its striking similarity in structure to the humerus of the heron. It belonged, according to Mr. Dennis, to a smaller kind than our common heron, and appears from a drawing which, with some fragments only of the bone, was all that he received, to be the distal end of the humerus of the heron. The bone possesses "quite the texture of bird-bone in its outward appearance, and is decidedly different from that of the Pterodactyle from the Chalk, which looks rather silky, an appearance apparently caused by fine lines on its surface, which the bird-bone is free from. The vertical section of a portion of this bone gives the following characters:—

"Haversian tubes for a bird of moderate thickness; reticulate, but without any precise form or size in the loops, but rather a marked irregularity is shown, some appearing square, others triangular, others oval,—in fact, of all shapes and sizes; sometimes they somewhat interlace; they do not entirely maintain a uniform diameter, the reticulations are inclined to form combinations, which produces a variety in their appearance, sometimes two or three of a similar shape and size uniting. The lacunæ are numerous, small ovals and round, but more pointed ones than round. The canaliculi are fine, much branched, and very numerous."

That this is the bone of a bird, from the evidence adduced, Mr.

* In a footnote, Mr. Dennis says he has observed something like this crossing in the skulls of some birds and in the bone-plates of the Armadillo.

† Such are the familiar characteristics of the known Pterodactyle bones from the Chalk and Jurassic strata.—ED. GEOL.

Dennis thinks there can be no doubt; and he therefore proceeds to attempt to discover what kind of bird it might have been. "We have no reason," he says, "to suppose it belongs to the Raptores, for it does not exhibit their peculiarities of structure, the Haversian tubes being peculiarly large in the diurnal birds of prey. Neither did it with much probability belong to the Corvidæ, for in them they are finer and more reticulate; still, neither did it belong to the Columbidæ or the gallinaceous family." All the goose, duck, and gull tribes, with the divers, perhaps mergansers or cormorants, may also be excluded, for they are reported, as far as Mr. Dennis has examined them, to have marked distinctions. By this process of separation, Mr. Dennis narrows the field of research, and "leaves us with the cranes, herons, egrets, and bitterns, and birds of that description," to discover a living representative of this ancient bird. He then attempts to show that "our common heron exhibits a very marked agreement in many particulars." "The bones of the heron, like those of other animals, exhibit a varied adaptation of their Haversian tubes, and certainly do not compare with the fossil in some of them,—as the tibia, for instance; but in the humerus there is a very great similarity, more so than in the ulna or radius. The Haversian tubes in the humerus appear to be constructed on the very same plan, so that a description of the one would be a counterpart of the other, only they appear rather larger in the heron. The lacunæ have also the same shapes, with nearly the same admixture of round ones, the heron appearing to have a greater number. The canaliculi also perfectly agree. Supposing the fossil bone to have been a humerus, its correspondence with the humerus of the heron would indicate that its wing was similar in shape, and its mode of flight corresponding." "Should further investigations," Mr. Dennis concludes, "substantiate this surmise, it will be another triumph of the microscope in the field of science." To these remarks Mr. Dennis adds "Addenda," which contain excellent remarks for obtaining examples of, and preparing bone-structure for microscopic examination, that may be read with much benefit by students and others interested in this subject.

Mr. Dennis's paper is accompanied by a plate (Micr. Journ. vol. v. pl. vi.), in which the following figures of microscopical sections are given:—1. Pteropus; humerus. 2. Bat; phalanx. 3. Flying Phalanger; tibia. 4. *Draco volans;* ulna. 5. Red-throated Diver; tibia. 6. Swift; furcula. 7. Mr. Catt's fossil (Pterodactyle). 8. Pelican; bill. 9. Stonesfield fossil, vertical section. 10. Ditto, transverse section. 12. Heron; humerus. 13 *a*. Heron; humerus. *b*. Stonesfield fossil; lacunæ. 14. Mr. Catt's fossil (Pterodactyle); lacunæ. 16. Heron; lacunæ. 17. Gannet; humerus. 18. Ditto; coracoid. 19. Ditto; furcula. 20. Ditto; femur, vertical section. 21. Ditto; femur, transverse section. 22. Ditto; tibia. 23. Ditto; tarsus. 24. Ditto; rib.

Of these, we have reproduced in our Plate V., as essential to the understanding of Mr. Dennis's arguments, fig. 9 to 16, namely the two vertical, and the transverse sections, and the lacunæ of the Stonesfield fossil; with the sections of the heron and Pterodactyle bones for comparison. Of these figures, 13, 14, 15, 16 are magnified 300 diameters; the remainder 75 diameters.

(*To be continued.*)

CORRESPONDENCE.

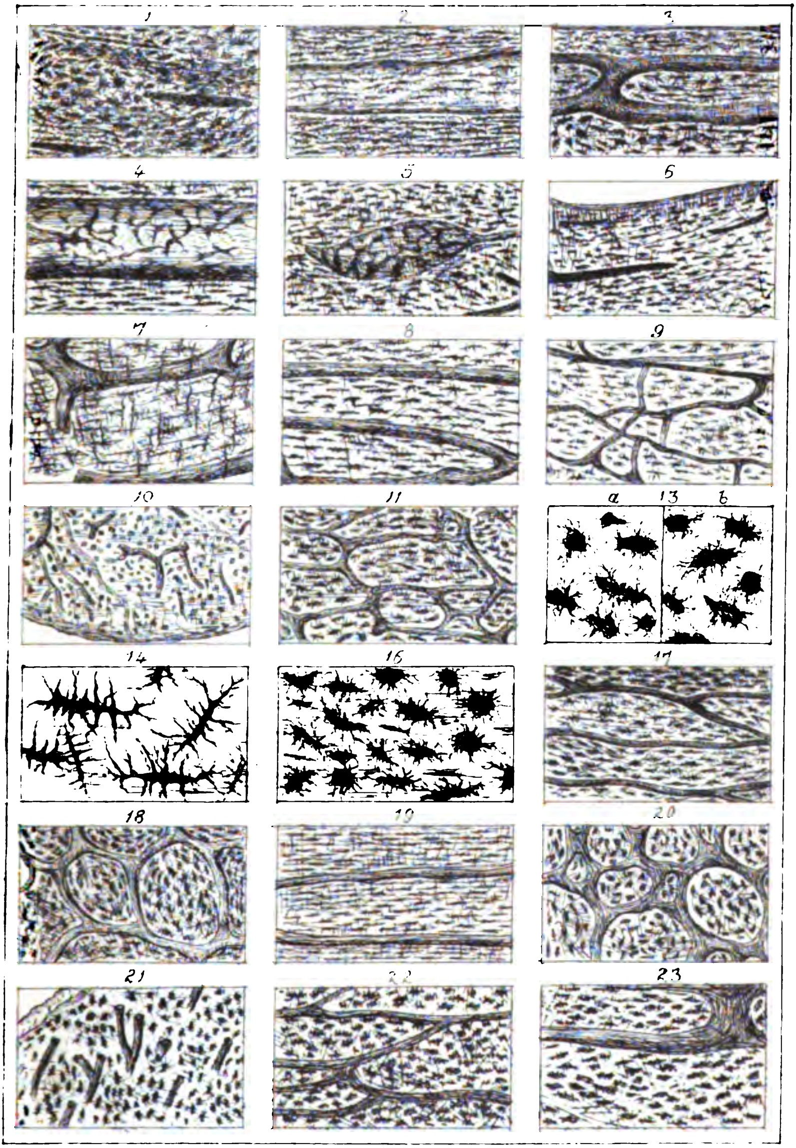
Human Remains and Flint Hatchets.

Sir,—Some weeks ago, in passing hurriedly through Normandy, I visited the museum of the ancient town of Bayeux, and was surprised to see in the same glass-case several flint-hatchets, etc., and various human bones. I anxiously made inquiry of the ancient librarian in the room, who, with sparkling eyes, gave ready utterance to his satisfaction at my notice of the contents of the case, and entered fully into a relation of their discovery; of which the following is the substance of a lengthy communication to the editor of 'L'Écho Bayeusain' of the 24th July, 1863, by Éd. Lambert St.-A. Duvant. I am unaware whether this paper is known to the British geologists; if it be not known, perhaps you will publish this communication, and draw attention to this locality; for it appears to me that this discovery, if fully verified, supplies the desideratum alluded to by Sir Charles Lyell in the following passage:—"It is naturally a matter of no small surprise, that after we have collected many hundred flint-implements (including knives, many thousands), not a single human bone has yet been met with in the alluvial sand and gravel in any of the parts of Europe where the tool-bearing drift of the Post-Pliocene period has been investigated in valley deposits." (Lyell, 'Antiquity of Man,' p. 144.)

Augustin Gilbert, a labourer, was occupied in excavating earth for the repair of a road (in the month of March, 1863), near the hamlet of Pont-Roch, on a portion of the territory of "D'Andrieu, called Les Perrelles," close to the banks of the river Seulle; and at the depth of 1 foot 10 inches below the surface, he discovered the remains of a human skeleton, near which was found a deer horn, lying by the upper part of the femur, and higher up, towards the skull, two flint-hatchets close together; a tusk of an old boar, measuring 5¼ inches in circumference, and a portion of a flint knife, of which only 3¼ inches remain of the blade, which is slightly curved at its upper extremity, is still very sharp on both sides; one face is flat, the other has two longitudinal grooves. The flint-hatchets are coated with an opaque substance; they are of different dimensions, quite polished, and worked with remarkable skill; the strongest is 6 inches by a width of 2¾ inches on the cutting edge, diminishing to 1¼ inch at the other end. The smallest, 4¾ inches long, with 1¼ inch on the cutting edge, reducing to ⅜ of an inch at the other end. The knife is of the same class, as regards the working of the material. The human remains are in a good state of preservation; one part of the maxillary bone contained seven perfectly sound teeth. The body was lying with its head towards the rising and the feet to the setting sun.

I am, Sir, yours faithfully,
Patrick Fraser, M.D.

63, Grosvenor Street, Grosvenor Square,
December 12th, 1863.



MICROSCOPIC SECTIONS OF FOSSIL BONES.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

GEOLOGISTS' ASSOCIATION.—The first meeting of the present session was held, November 3rd, at the rooms of the Medical Society of London, George Street, Hanover Square, whither the Association has removed. A paper was read by Mr. Carter Blake on "Fossil Elephants," which elicited some very interesting remarks from Mr. Charlesworth, Mr. Cresy, and Professor Tennant, the President. Mr. Evans then read a communication on the geology of the railway-works in the vicinity of London, and illustrated his paper by an exceedingly interesting suite of fossils.

MANCHESTER GEOLOGICAL SOCIETY.—The twenty-fifth Annual Meeting was held at the Museum, Peter Street, on the 29th October last. The Report showed the Society in a very prosperous state.

The following gentlemen were elected office-bearers for the ensuing year:—President: Andrew Knowles, Esq. Vice-Presidents: E. W. Binney, F.R.S., F.G.S., Sir Jas. P. Kay-Shuttleworth, Bart., F.G.S., Joseph Dickinson, F.G.S., W. Roby Barr, Esq. Treasurer: Mr. Henry Mere Ormerod. Auditors: R. P. Greg, F.G.S., Mr. James Hertz. Honorary Secretaries: John Atkinson, F.G.S., John Edward Forbes, F.G.S. Honorary Curators: Mr. E. W. Binney, Mr. H. M. Ormerod. Council: Mr. Thomas Ashworth, Mr. John Bradbury, Mr. Joseph Chatwood, Mr. John Cross, Mr. Thomas Farrimond, Mr. Joseph Goodwin, Mr. G. C. Greenwell, Mr. J. J. Horsfall, Mr. Clegg Livesey, Mr. George Peace, Mr. John Taylor, Mr. John Wild.

Representatives of the Society at the Council Meetings of the Natural History Society—Mr. E. W. Binney and Mr. Alderman Harvey.

SOUTH SHIELDS GEOLOGICAL CLUB.—The anniversary meeting was held on the 13th November. In addition to the independent investigations of members of the South Shields Geological Club, the Club have found it exceedingly interesting and instructive to pursue, during fixed winter evenings, a systematic and practical examination of geological phenomena, for which the numerous lithological and fossil specimens in their possession, or procured during various explorations, have supplied ample and admirable materials for comparison and illustration.

The important advantages that have been already derived from the establishment of the Club, have abundantly demonstrated the great value of the application of the co-operative principle, even to the active pursuit of natural science.

The President's Address referred to some points of geological interest connected with the ground traversed during the preceding season, and indicated the special departments that would occupy consideration during the one now approaching.

The coal-fields of Durham and Northumberland are traversed in various directions by Basaltic dykes, which at several points are exposed, and good opportunities afforded for observing them. The most remarkable of these igneous masses in the North of England is the great whin sill, so named, in contradistinction to whin *dyke*, on account of its stratiform character, and general conformability to the stratified beds on which it rests. It is composed chiefly of Greenstone and Basalt, and extends from Brough, in Westmoreland, to within a very few miles of Berwick-upon-Tweed. It is generally of one stratiform mass, but sometimes two, and even three, stratiform beds occur. The course of the whin sill, from the Pennine range, is in a north-easterly direction, and after crossing the North Tyne appears at Bavington, and on the east coast at Dunstanburgh Castle, where it forms a high escarpment facing the sea, and affords the very best opportunity for observing the vertical columnar structure which it here assumes, with the usual lateral jointings. It again appears at Bamburgh Castle and the Farne Islands; at the former, the columnar masses incline to an angle of forty-five degrees, as at Holy Island, where it is again seen, and thence proceeds to the Kyloe hills, six miles northward from Belford.

To account for the introduction of the whin sill into the limestone strata, two theories have been advanced. Mr. Hutton maintained that the Basaltic lava was poured out on the bed of the ocean, at one or more periods, during the deposition of the limestone strata, and thus became interstratified amongst them. Professor Sedgwick, on the other hand, entertains the opinion that the eruptive lava, during a later period, forced its way into the previously deposited rocks, along their surfaces of stratification, and thus elevated the whole mass of superincumbent strata.

Each hypothesis encounters its own peculiar difficulties while endeavouring to account for all the phenomena. From his own observations of the whin sill, which have been confined to its more northern course, the President was led to adopt, in preference, the hypothesis of Hutton. The force required to have horizontally opened and intruded so large a mass of igneous matter into the limestone beds for so many miles would be enormous, and was almost certain to have dislocated and greatly broken the superjacent strata, and to have intruded dykes and veins of Basalt in all directions into the adjacent fissures. Dislocations evidencing great violence in their production, and the intrusion of Basaltic masses, however, are nowhere observable. Of the numerous faults that traverse the northern coal-field, two may be seen in our immediate neighbourhood, namely, the dyke in Tynemouth Cliff, and the ninety-fathom dyke near Cullercoats. The latter is of much geological interest, arising from the vast dislocations and remarkable downthrow of the strata it has effected along its whole uninterrupted course of one hundred and thirty miles. This great fault begins at the northern termination of the Pennine chain, and runs eastward to the sea-coast at Cullercoats, and has caused a relative depression of the limestone strata on the north, estimated at some points at not less than two thousand feet. The depth of the downcast, however, varies much at different places: at Cullercoats it is nearly fifty fathoms. The fault can be best seen and studied at Cullercoats and Whitley, for here it has dislocated not only the coal-measures, but also the Lower Red Sandstone and the magnesian limestone of the Permian series. The beds are invariably depressed on the north side, and dip towards the fault, the plane of the dislocation being about fifty-nine degrees. The surface of the overlying sandstone is marked along the dip of the fault by numerous parallel flutings made by the intruded mass, affording the clearest evidence of the great violence with which the displacement was effected. The course of the dyke from Cullercoats to Gosforth is W.N.W., thence W.S.W. across the Tyne about three miles above Newcastle, and thence W. to Brampton, where it bends in a nearly S.E. by S. direction to Brough; from Brough to Wild Boar Fell nearly S.W., and thence to Graygarth, S.S.W.; from Graygarth to Wharfdale, E.S.E., turning a little more eastward as it approaches the Wharf. The geological age of this great igneous eruption seems pretty accurately indicated. It divides the lower Permian beds at Cullercoats, but does not appear to have dislocated the Triassic Red Sandstones in its western course. It must, therefore, have been intruded either about the time of the deposition of the middle, or of the upper, beds of the magnesian limestone—certainly not later than the deposition of the latter. The course of the Basaltic dyke seen in the cliff at Tynemouth, where it passes into the Permian Lower Red Sandstone, has evidently a westerly direction, but it has not been traced; its relations, therefore, are not precisely known. In mineral character it is a compact labradorite.

Having thus briefly adverted to a few points of geological interest connected with the ground traversed during the last winter evening meetings of the Club, it only remains for me to indicate the departments of geological inquiry to which our attention will be directed during the present season. The coal-measures will receive our first consideration, more especially as they immediately succeed the Devonian system, which has already received some considerable attention. The fauna of the formation, as we shall see, acquires still further development, in harmony with the general law of progression that regulated the introduction of organic existences from the Cambrian epoch, through all the succeeding periods, to the close of the Tertiary, when it culminated in man. It is a curious fact that not a single species of the singular bone-encased fishes of the Old Red Sandstone survived the close of the Devonian period, these fishes not having a single representative in the coal-measures. Seeing the period of transition from the one to the other was apparently quiescent, free from violent or sudden upheavals of the earth's surface, to what causes are we to attribute their extinction? The flora of the Carboniferous system is its distinguishing characteristic, and its exuberant vigour is very remarkable when compared, or rather contrasted, with the paucity and apparent feebleness of the preceding Devonian vegetable forms. The Permian series, another local formation, though not so important, in an industrial point of view, as the Carboniferous, is, nevertheless, one of considerable interest. The attention of the Club will also be directed to this series, the last of the Palæozoic divisions. The formation is so well developed in our immediate neighbourhood, that frequent opportunities will arise for examining together the many excellent sections of the strata it contains.

In conclusion, the President congratulated the members of the Club on the vigour and success that had hitherto characterized their operations, and on their enthusiastic devotion to scientific investigations at once so instructive and entertaining.

COLONIAL GEOLOGY.

GEOLOGICAL NOTES ON THE COUNTRY NEAR MELBOURNE, VICTORIA.

By Thos. Harrison.

Australia offers both advantages and the reverse as a field wherein geology may be studied. Mesozoic strata being absent, or very sparingly developed, the variety of fossils is not extensive; but some of the phenomena observable are by no means devoid of interest.

The very limited portion of the Australian continent which I purpose describing is delineated upon sheet number 1 of the geological map lately issued by Mr. Selwyn,—a reduced sketch-copy of which is enclosed with the present communication (Pl. VI.).

By this map it will be seen that there are at least three classes of strata to be noticed—Silurian, Tertiary, and Volcanic. The site of the Victorian metropolis, together with the suburban townships, comprises the whole of these in various proportions. Melbourne proper, with the exception of its extreme western portion, which is situate on an older volcanic formation, is built almost wholly upon May Hill sandstones and soft laminated shales. The whole of this stratum has evidently been subjected to immense disturbance, it being a matter of no little difficulty to discover a patch many yards in extent within which the beds even approach to a horizontal position. The general inclination of the stratification more often verges on the perpendicular, whilst numerous contortions, folds, and doublings—the upper edges being cut away by denudation, at the same time that the lower are hidden far below the exposed portion—offer an interesting but withal most difficult problem to the geological student.

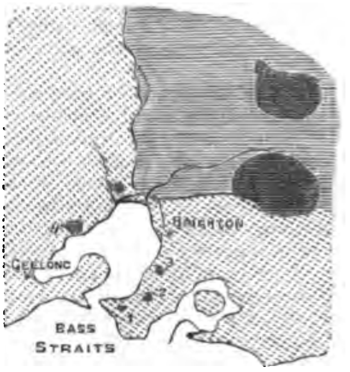


Fig. 1.—The shaded portion is Silurian; the very dark tint, Granite; the dotted, Tertiary, and Tertiary covered by basalt. The references are :—1. Arthur St. 2. Mt. Martha. 3. Mt. Eliza. 4. Yowangs.

Very many of these contortions may perhaps be explained by the supposition of alternate elevations and depressions, but not a few are so intricate as to provoke queries by no means admitting of an easy answer.

In some of the yet unpaved streets of the metropolis, for example, protruding edges of the shales resemble the piles of slates, seen from above, in a stone-mason's yard. Opposite the Supreme Court, several bends in the strata suggest the idea of a loosely-bound book forcibly pressed together from the two ends; the inner and concave side being puckered up, whilst the outer curve is correspondingly stretched and fractured. In a fine section afforded by a cutting in Studley Park, the beds are nearly vertical, leaning towards each other above a pretty clearly developed anticlinal; such anticlinal, however, would seem rather to have been caused by lateral compression than by simply upheaving forces acting from beneath. At Keilor, a township about ten miles on the road to Castlemaine, a natural section displays contortions not unlike the letter S reversed and placed horizontally (part of this curve is shown in the annexed sketch, Pl. II.), traces of the bend being distinctly visible on the opposite sides of the valley, —one of denudation,—at least 200 yards distant. And on removing the surface of Collins Street eight or nine years since, arrangements similar to the ground plan, Fig. 3, presented themselves, none of which seem capable of being accounted for by simple geological forces acting vertically.

Fig. 2.—Bend in strata at Keilor, opposite side of valley to that represented by Pl. II., and near the spot whence the latter was taken.

A somewhat remarkable feature of the strata referred to, is the frequent protrusion of Elvan dykes. Several of these masses are represented on the map by waving lines. From the condition of the closely adjacent

BEND IN SILURIAN STRATA, AND HILLS CROWNED WITH BASALT, KEILOR.

S. J Mackie, del. [From a Sketch by Mr. Harrison.]

rocks, these dykes would seem to have been thrown up in a heated state They occur in many places, but being generally denuded down to the level of the surrounding rocks, traces of their existence are only discoverable by

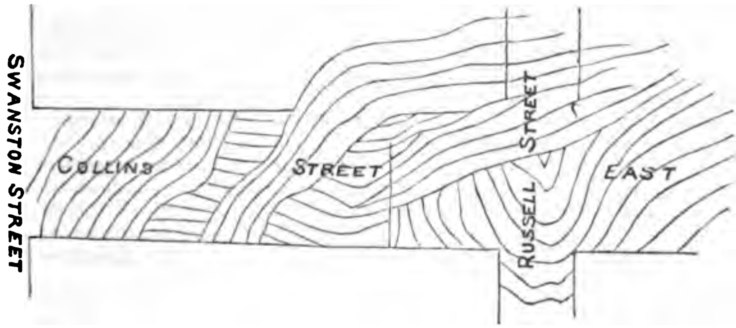


Fig. 3.—View of the strata near the junction of Collins and Russell Streets. I am indebted for the sketch to a paper read by M. Blandowski before the Royal Society of Victoria. The sketch represents the surface as looked down upon from above.

the accidental labours of the quarryman. The fact that these (the dykes) are of an ancient date is most satisfactorily shown by numerous palæozoic conglomerates being evidently formed from these eroded materials, and from their being seen to penetrate the Lower Silurian rocks, whilst the upper beds of the same formation rest perfectly undisturbed above.

Another feature worthy of notice is found in the quantity of quartz veins with which the Silurian beds are penetrated. The black lines representing these, all having a nearly meridional strike, is quite a feature on maps of the districts wherein they abound. On the diggings, such veins are, as may be supposed, auriferous; but quartz is found in many localities wherein no trace of gold can be discovered. The sandstones of Studley Park, east of Collingwood, are often singularly intersected by this mineral, some of which, even in this locality, would seem to contain specks of the precious metal, since gravel brought from the neighbourhood often displays gold in minute portions. I may mention that the Collingwood Mining Company are sinking a shaft through the "blue stone" (basalt) for the purpose of testing the bottom covered by the detritus of these rocks, and are sanguine of success.

The fossils in the Melbourne Silurian formation are tolerably numerous; but although many of the beds contain a profusion of marine exuvia, literally cemented together, like pebbles in a conglomerate, others are apparently barren of all vestiges of life or its evidences. Such a state of things would seem to tell of periods of repose and subsequent convulsions, long ago, when life became marvellously abundant, followed by others equally extensive, during which every moving thing came to be destroyed, and when only thick beds of sand, fine clay, and dense impalpable mud accumulated in sea-bottoms untenanted by a single organism endowed with life, unenlivened by even a vegetable form.

As avoiding such a theory, I am reminded of an hypothesis put forth by the late Hugh Miller, that in somewhat similar barren rocks alternating with a profusion of organisms, the shells had probably sunk by gravity through the quicksand surrounding them, and that the fossiliferous beds so formed had subsequently been cleared of the remaining sandy particles by the gradual percolation of water through their midst. The particular conglomerates I am describing would, however, appear to present somewhat different conditions, the barren portions being at the bottom and the shelly masses forming the upper stratum,—suggestive, perhaps, that the shells, being light and comparatively large, took a superior position, whilst the more weighty sand was washed or shaken through, on the principle that causes the larger and unbroken biscuits, if I may be allowed the simile, to occupy the upper part of a cask, while the dust and "midshipmen's nuts" just as assuredly seek the bottom.

In consequence of the foldings and contortions to which these Silurian beds have been subjected, as may be supposed, a great variety, both of fossils and lithological characteristics, are crowded into a comparatively small space. Near the Botanical Gardens, situate on the southern banks of the Yarra-yarra, and not far removed from two of the Elvan dykes marked on the map, the strata are composed of soft micaceous sandstone, generally friable, and apparently much broken up and dislocated by past convulsions.

The fossils in this locality are numerous, but small in size; Orthidæ, Leptænæ, with a kind of spiral univalve, probably a Euomphalus, being the prevailing types. Close beside the beds wherein these organisms prevail are others destitute of fossils, but containing nearly spherical bodies of perhaps half an inch in diameter, and generally having a badly defined stem-like projection on one side, the stem being sometimes continued for several inches, until ultimately lost in the surrounding matrix. On being newly fractured, these bodies appear of a fine lake colour, mottled with lighter tints, but fade and become dim after a few days' exposure to light and air. They are not yet named in the University Museum, although some few are therein exhibited. An infiltration of peroxide of iron and manganese may perhaps account for both the colour and the phenomenon; but it is questionable whether these latter substances may not have been attracted by some animal or vegetable remains forming a nucleus, which has since disappeared.

In a quantity of stones recently excavated from a sewer communicating with the Parliament Houses and Treasury—a manor particularly poached over by myself—I have met with Holopellæ (?), Orthidæ (very small), Cuculellæ (the shells still attached to each other, but generally open and filled with the surrounding stone), broken fragments of an Orthoceratite with transverse corrugations, Trilobites, and *Creseis Forbesii*. These latter pteropods, I believe similar to a species now found in the Mediterranean, are especially numerous. The general size is 1½ to 2 inches, although one specimen, unfortunately fractured, must have been nearly 5½ inches in longitudinal dimensions.

The above are nearly always found in the soft sandstones of the locality, whilst the shales of the same place contain large quantities of a species of worm many inches in length, which I do not find depicted in any work on the Silurian deposits in my possession.

At Carlton Butts, about 1½ mile north-east of Melbourne, the fossils, although thinly scattered, are remarkable for being in a remarkably fine state of preservation. Shales and sandstones predominate in this locality also, but are much harder than in the place last described. A peculiarity of the fossils found in this spot is their singularly rich colouring when only recently obtained. On laying open, at a single blow of the hammer, a fine specimen of the tail portion of an Asaphus (?), as it appeared a beautifully sculptured and lake-tinted object on the cream-coloured mass of surrounding stone, I almost thought the fossil some new species of moth or butterfly miraculously imprisoned in a rocky matrix. The colouring is not confined to particular organisms, but is due probably to the same causes as are the colours of the fossils in the Botanical Garden quarries.

Moonee Ponds is, and perhaps will long remain, the most plentifully stocked preserve for the Melbourne collector. The prevailing rocks are shales and sandstones, the latter, in many places, being literally made up of marine exuvia, matted together, organism upon organism, in such a manner as to render the extraction of a perfect fossil a matter of some little difficulty.

The general custom of these beds as depicted on both maps, but more especially that which shows the surrounding country on a smaller scale, present an outline peculiarly suggestive. It will be observed that the borders of the formation are turned principally towards south and westerly points of the compass, the eastern boundary abutting against the granitic and porphyritic masses of the Dandenong ranges. Seen alone, as there represented, the above fact might be deemed hardly worthy of remark; but the bold cliff-like escarpments which form the outline in many places, such escarpments having almost invariably a south or westerly aspect, suggests the cause, and tells of strong currents, oceanic action, and a steep and rocky shore exposed to the full fury of an extensive and stormy waste of water. Near Melbourne, in Studley Park, overlooking the flats of Richmond and Collingwood, the feature alluded to is strikingly apparent. Standing on the lower ground, the resemblance to a precipitous coast is especially manifest; whilst gazing from the summit, one is almost inclined to fancy the many undulations of the ground below are the arrested billows of some ancient sea. At times, as a thick fog covers the plain beneath, and when the higher portions of city and suburb just peep out of the mist-like islets, the old and fancied state of things seems realized; whilst from the Tertiary beds below and their wide extension, almost universal in a south-westernly direction, save in the case of a few granitic masses, Mount Eliza, Mount Martha, Arthur's Seat, and the Yowangs, the student well knows that the time could not be geologically far distant when the waves, breaking near the spot whereon he stands, came rolling in from an expanse of ocean uninterrupted by land, rock, or island, nearer than the Falklands or the Horn.

Tertiary deposits are developed to a great extent over the whole of Australia, and are well represented in the Melbourne district; more so, in fact, than appears upon the map, since they both overlie and underlie the basaltic lavas, and besides cover with a thin capping in many places the upturned edges of the elder Silurian strata.

A tolerably good view of the Upper Tertiary beds can be obtained by following the line of the Melbourne and Brighton railway, along which, after the first few miles, where Basalt and outlying patches of Silurian rocks are traversed, some thick beds of the newer Pliocene are exposed. In a cutting near Chapel Street station, three or four miles south-west of Melbourne, a junction of the older with the newer rocks discloses a somewhat instructive section. The Silurian beds had there formed an abrupt coast-line, or at least an uneven and rocky bottom, and upon them rests in unconformable stratification the Tertiary sediment above,—forming a number of thin beds, gradually growing less and less curved, until attaining 3 or 4 feet in thickness, when all traces of the uneven bottom is lost by the succeeding deposits being thrown down in nearly level lines.

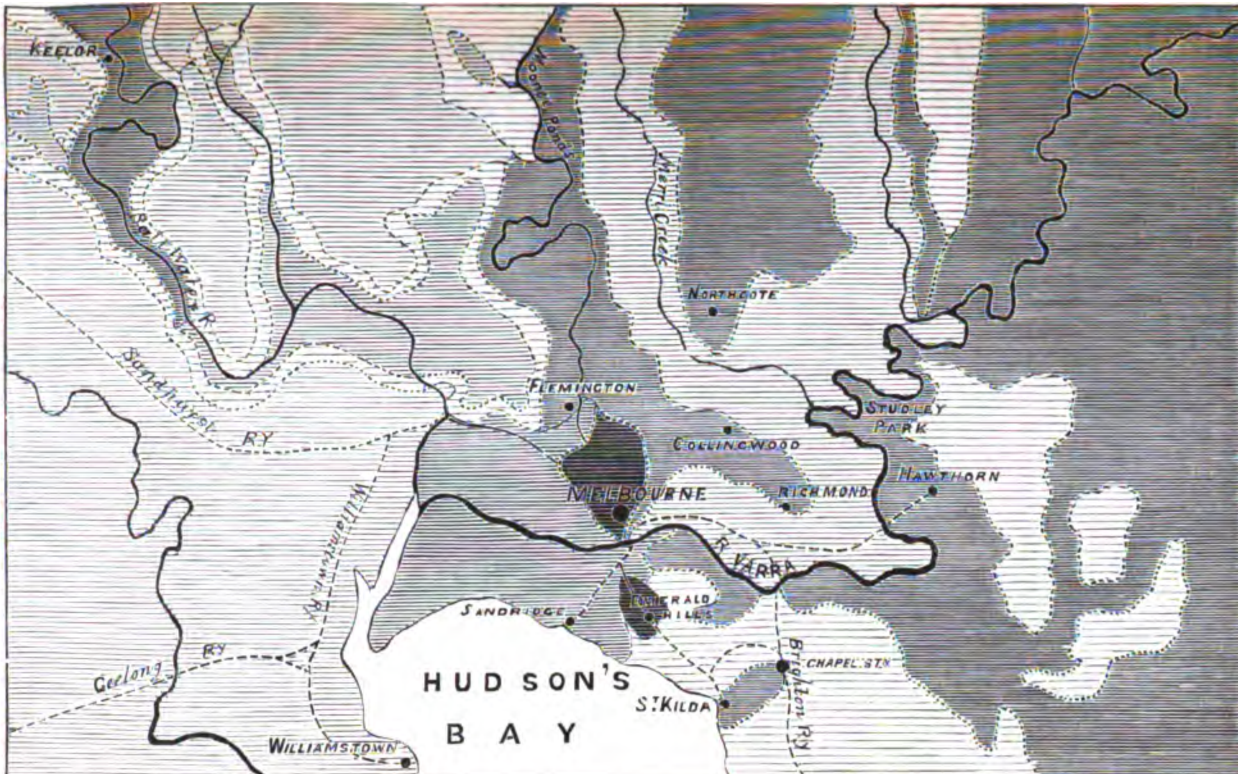
From this point on the line the same Tertiary beds are exposed in each succeeding cutting as far as Brighton, a suburban watering-place eight miles from the metropolis, on the shores of Port Phillip Bay. On the beach near Brighton, small outcrops of Lower and ferruginous Pliocene beds first present themselves, and, pursuing the line of coast, these are found gradually increasing in thickness until a cliff is exposed some 50 to 80 feet high, formed of the first-mentioned beds above, and the latter lying in conformable stratification at the base.

These latter beds are somewhat remarkable near this place (Pic-nic Point) for being filled with a vast number of tubular-shaped bodies, covered on the outside with warty excrescences. These tubes vary in size from the thickness of a straw to that of a man's wrist. Within them there is generally found a core, easily removable by a little gentle pressure. The outside of the tubes in question being harder than the other portions of the strata, they, of course, resist the action of the waves more successfully, and stand out from the containing matrix in singularly bold relief; often, when half imbedded, reminding one of some huge chiton clinging, for bare life, to his stony habitat, upon which he has been left high and dry by the receding tide. Although bearing a very strong resemblance to fossils, the appearances witnessed are generally regarded by local geologists as due to the decomposition of hematite, with which the same kind of rock is known to abound.

The upper beds in this particular spot, represented by a soft arenaceous stone, do not appear to be fossiliferous, but also contain certain tubular bodies —very different, however, from those last mentioned—generally traceable for many inches at a time, and of a chalky appearance, Having forwarded a small hand-specimen to the Rev. J. E. Woods, of Penola, that gentleman suggested they might be a species of fulgurite due to the action of lightning,—a theory which seemed to be especially favoured by the tubes being invariably found in the higher portions of the strata, and nowhere traceable at a few feet from the surface. Subsequent observation has, however, would seem to show that these appearances must be referred to a far less romantic origin than "the fire of Jove;" in fact, on examining them more closely, many appeared to be filled with a black and crumbling substance resembling decayed vegetable matter, and on searching still further, I discovered one in which a piece of wood, evidently the root of a shrub or tree, was still contained. Since then I have met with similar specimens in Melbourne among some Tertiary rocks near the gaol, and also at Northcote, where a thin capping of newer Pliocene deposits rests on the Silurian strata. In this latter instance I observed many recent roots, running downward into the loose rock almost perpendicularly, around which the sand and fine gravel appeared to be invariably hardened into a cemented pipe-like mass. Having tested these tubes with muriatic acid, I should not expect them to contain lime, as I once supposed. More probably, the potash in the wood combining with the surrounding quartzose sand, has given rise—first to a solution, and afterwards to a deposition of siliceous particles.

Much of this district, near Brighton, is covered on the surface by deposits of shells several inches in thickness, wherein Cardium, Turbo, Trochus, Haliotis, and other species having representatives in the adjacent sea, are found in great abundance. In some places, these shelly deposits, being mixed up with arenaceous matter and small pebbles, by afterwards partially decomposing form a soft, easily broken, shelly gravel or conglomerate, interesting to the young geologist, since he can thus readily trace every step of the process which changes the loose sand, unconsolidated pebbles, and aggregated shells, into a tolerably firm and stony rock of highly fossiliferous character.

The evidence of these shell-beds goes far to show the very recent upheaval of the surrounding district. A little observation will, however, reveal traces of more than one phenomenon of this description, together



MAP OF MELBOURNE DISTRICT, VICTORIA.

[The area included is about 200 square miles.]

with a corresponding submersion. At the immediate junction of the lately-described Upper and Lower Tertiary beds, for example, not only is the upper surface of the latter waterworn, but the rock itself, for many feet in depth, is fretted into numerous fissures, subsequently filled up with material exactly corresponding with that comprising the rock above ; thus a distinct proof is afforded of the underlying rock having formed an old coast-line, or at least a rocky eminence nearly awash with the waves, from which position the whole afterwards sank sufficiently deep below the water to allow of nearly 20 feet of newer strata being deposited at a later period.

Still further proof of these changes of level is afforded by certain formations around Geelong, at which place thick beds of limestone, containing Planorbis, Lymnea, Paludina, and other limestone and fluviatile shells, appear above Miocene and beneath nearly 20 feet of Marine Pliocene deposits ; thus necessitating an upheaval over a portion of the country large enough to allow of freshwater lakes being formed, and a subsequent submersion of the whole district, in order that the marine strata might be thrown down.

These continued elevations and depressions of surface are not a little puzzling to the tyro scarce willing to admit the possibility of any such phenomenon in a single instance. The district, however evidently volcanic, would appear to have been especially subject to the changes spoken of,—a rise generally preceding, and a submersion succeeding, each outburst of lava. Nor is it at all improbable, from recent observations, but that the land over the whole of Port Phillip Bay is still rising,* whether to be followed by a renewed outpouring of igneous rocks and a fresh submersion is beyond the power of science to foretell.

No account of the Melbourne district would be complete without some mention of the Basalt—the *bête noire* of the miner, the material of half our public buildings, the substratum of so many Australian plains, the core of so many of our hills, and the allowed source of the colony's fertility. This particular rock is of various ages ; no less than three different intrusions or outflows are traceable on the map annexed. The newer or Basalt proper about Victoria, in vast irregularly-shaped patches. On careful exploration, these generally show traces of having been ejected in some higher portion of the land, filling up the adjacent valleys with a once molten but now solidified mass. At first view, few mineral substances would seem less capable of being acted upon by the elements. Yet the fertile soil, composed wholly of basaltic clay and sand, together with huge boulders, masses left by the decomposition of the rock around them, show that so indurate a material is by no means proof against such comparatively weak forces as atmospheric actions. The denuding power of water is also strikingly shown where the Merri Creek has cut its way in a channel, 60 feet deep, through basaltic beds for many miles. Still more remarkable is the denudation of the Keilor Valley. At this place, not only has the Basalt been removed, but 20 feet of Tertiary, and from 30 to 40 feet of Silurian rocks have been cut through also ; thus leaving a number of semi-detached hills, each having a base composed of shales and Palæozoic sandstones, strangely distorted by ancient convulsive movements ; a middle portion, formed of Tertiary deposits, lyingun conformably upon the older rocks below, and on their summits a thick capping of

* The 'Lightning,' Black Ball liner, lately struck upon a rock near the Heads, which had never been laid down in any chart, probably because the depth at which it lay had decreased since making the first survey of the channel.

spheroidal, and in some places columnar Basalt,—a study to the Victorian geologist, little, if any, less instructive than the trap-surmounted hills of Ardèche or the volcanic district of Auvergne.

Melbourne, September 9, 1863.

NOTES AND QUERIES.

The Graham Shoal.—Several notices have lately appeared in the 'Times' upon the re-discovery of Graham Shoal, off the coast of Sicily, and lying nearly in the track of the mail-steamers running between Marseilles, Malta, and Alexandria. There had been for several years rumours that the shoal had sunk to such a degree as to be no longer dangerous to shipping. To verify this, her Majesty's ship Argus, Captain Ingram, was sent in October, 1861, and employed for several days in searching for the shoal, without success; and from the report of her survey, supported by the opinions of the fishermen of Sciacca and Girgenti, it appeared that the accumulation of cinders and scoriæ that had been heaped up by an eruption of a submarine volcano, and formed the shoal, had gradually dispersed.

When Etna was reported last summer to be in a state of eruption, Mr. Almona, of the Peninsular and Oriental steamship Valetta, mentally connected the fact with Graham's Shoal, considering the same causes that were influencing the larger mountain might also affect the hidden crater, and he determined to give the old spot of the shoal a wider berth in passing. The late survey of the 'Growler' has found the bank again; and whether the 'Argus's' search was in fault, or that it has newly again come to the surface, must be a matter of surmise.

Cretaceous Terebratulæ.—One of the species described by Mr. Lankester in your November number (*T. Moutoniana*, D'Orb.) is a common shell in the Lower Greensand of Godalming. Of the other (*T. depressa*, Lam.), I found a fine specimen at Shanklin, in 1861. The specimen figured on Pl. XXI. Fig. 5, scarcely, however, represents *T. depressa*, as in that species the deltidium is *in one piece*.—C. J. A. Meyer.

Wasium has been described by M. Bahr as existing in Norwegian orthite, in that of the island of Rænshohm, as well as in the orthite of Ytterby. He finds it in the state of oxide associated with silica, alumina, iron, yttria, ceria, didymia, lime, manganese, etc., but these minerals hardly ever contain more than one per cent. of wasa, or the oxide of Wasium. A paper by M. Nickles is recorded in the Comptes Rendus of the French Academy, in which the existence of Wasium, as a simple body, is disputed, and reasons assigned for believing Wasium to be only a complex oxide, or yttria coloured with a little oxide of didymium or terbium.

Sections on the Lewisham and Tunbridge Railway.—Dear Sir,—In the course of last summer a tunnel was commenced on the new line of railway from Lewisham to Tunbridge, in the neighbourhood of Elmsted Lane, Bromley, where a very interesting and highly fossiliferous deposit has been brought to light.

A considerable tract of country around Bromley is occupied by a thick deposit of rounded flint pebbles in sand, concreted portions of which have long been known as the "Bromley Oyster Conglomerate."

These pebble-beds are exposed in the open cutting at the south end of the new railway tunnel, but no fossils are seen in this section. In the interior of the tunnel, however, the lower portion of the deposit consists of a fine light-coloured pebbly sand and a band of hard conglomerate, both of which abound with a very fine species of Pectunculus (*P. brevirostris*), well preserved. Together with this shell are others, some of which belong to London Clay species, others are those of the Woolwich and Thanet sands series, and several are, I am inclined to believe, undescribed.

The following are those which I have been able to name with tolerable certainty:—*Ostrea Bellovacina*, *O. tenera*, *Cardium Plumsteadiense*, *C. Laytoni*, *Corbula Regulbensis*, *C. Arnouldii*, *Cyrena cuneiformis*, *C. cordata*, *C. intermedia*, *Cytherea*, *Modiola Mitchellii*, *Pectunculus brevirostris* (very abundant), *Arca*, *Avicula*, *Nucula* (new species), *Cerithium funatum*, *C. Bowerbankii*, *C. Lunnii*, *Calyptræa trochiformis*, *Auricula pygmæa*, *Fusus latus*, *F. gradatus*, *Melania inquinata*, *Murex*, *Melanopsis buccinoides*, *Natica glaucinoides*, *N. subdepressa*, *Neritina globula*, *Odostomia*, *Pseudoliva semicostata*, *Pitharella Rickmanii*, *Ringicula turgida*, *Tornatella*, *Trophon subnodosum*, *Valvata*, *Serpula*, *Lamna*. To these I add, with some doubt, *Sanguinolaria Edwardsii*, *Anomia*, *Fusus tuberosus*, *Scalaria Bowerbankii*, *Neritina concava*, *Eulima* or *Rissoa*. I also add, on the authority of my friend Mr. C. J. A. Meyer, *Lucina*, *Tellina*, *Teredo*, *Melania* (? new species), *Melanopsis ancillaroides*, *Scalaria* (? new species), *Fusus* (? new species), *Turritella*, *Otodus*.

My friend Mr. Bott possesses a fine specimen of *Pholas* from this spot.

A few weeks since I directed the attention of Mr. Edwards to this locality, and as that gentleman appears to be much interested in these fossils, proper notice will doubtless be taken of any new species.

A deposit of pebbly sand is evidently the production of water having considerable transporting power. It is therefore not surprising to find, that since the most abundant fossils are of marine species, those of a freshwater or estuarine character, such as *Cyrena*, *Melania*, *Pitharella*, etc., are much waterworn. The relative position of this bed is not shown in the sections now exposed, as the pebble-beds extend to the top of the hill. It is, I believe, about 60 feet above the Chalk, from which fact, and also from the general character of the beds, I feel inclined to place it at or near the top of the Woolwich series of beds, and not far below the London Clay. This is the position assigned by Mr. Prestwich to the conglomerate bed in Sundridge Park.

It will also be interesting to state that the long tunnel at Sevenoaks, on the same line of railway, cuts through the Neocomian or junction beds between the Weald Clay and the Kentish Rag. At the south end of the tunnel clay and stone, with *Cyrena*, *Paludina*, etc., are seen in the spoil-heaps around the shafts. Following the tunnel to the north (the line of the dip of the beds), clays with *Cerithium* appear, which are succeeded by more sandy beds abounding in marine fossils, *Arca Raulinii*, *Perna Mulletii*, *Corbula elegans*, etc.

Above this bed is a thick deposit of Kentish Rag and Hassock. I hope on a future occasion to be able to furnish you with a list of the fossils from this bed.—Yours truly, CALEB EVANS.

3, *Devonshire Hill*, *Hampstead*, 10*th December*, 1863.

MISCELLANEOUS NOTICES.

The following geological and archæological articles appeared in the 'Dublin Quarterly Journal' for May last year:—"On the Flint Implements found in the Gravel of St. Acheul, and their mode of Occurrence," by J. Beete Jukes, F.R.S.; "Report of Council of Dublin Geological Society for 1862–3;" "On the Chemical and Mineralogical Relations of Metamorphic Rocks," by T. Sterry-Hunt, F.R.S., of the Canadian Survey; "Description of an Oak Pile found in the Lake of Geneva," by Mr. Starkey.

The 'Annales de Chimie et de Physique' for August last, contains a note by M. Regnault "On an Apparatus for the Fractional Distillation for estimating the Venale Value of the Essential Oils which are produced by the Calcination of Coals and Schists."

The 'American Journal of Science' for November, 1863, contains the following articles:—"On certain Parallel Relations between the classes of Vertebrates, and the bearings of these Relations on the question of the Distinctive Features of the Reptilian Birds," and "On the Classification of Animals based on the Principle of Cephalization," by Professor J. D. Dana; "On the Rocks of the Quebec Group at Point Lévis," by Sir William E. Logan; "Remarks on the Causes producing the Different Characters of Vegetation known as Prairies, Flats, and Barrens in Southern Illinois, with special reference to Observations made in Perry and Jackson Counties," by Herr Engelmann, of the State Geological Survey; "On the Earth's Climate in Palæozoic Times," by T. Sterry-Hunt, F.R.S., Chemist to the Canadian Survey. Amongst the notices are:—"On the Phosphatic or Guano Rock of the Island of Sombrero," recently described as a new species of mineral by Dr. Phipson, under the name of Sombrerite. This notice is by M. Julien, a resident chemist at Sombrero, who gives a great deal of information about its extent and physical characters, disputes the accuracy of Dr. Phipson's statements, and asserts that the Sombrero guano is as variable in its composition as any other phosphatic guano, and as little entitled to rank as a new species. "Dr. Phipson," he adds, "cannot possibly have examined with any care a single cargo, I venture to say not even a single ton; for there is no natural standard by which a representative specimen could be 'well chosen' or chosen at all." "On the Nature of Jade, and on a new Mineral Species described by M. Damour," by Mr. T. Sterry-Hunt. Geological Survey of Canada: Report for 1863.

The following books and papers have been recently published:—'List of the Echinoderms sent to different Institutions in exchange for other Specimens, with Annotations on the Characteristics of the Species, Localities, Authorities, etc.' By A. Agassiz. 'Beiträge zur Kenntniss der fossilen Pferde und zu einer vergleichenden Odontographie der Hufthiere im Allgemeinen.' By Prof. L. Rütimeyer. Basel, 1863. This work, devoted to the fossil horses and related Ungulates, is illustrated with four plates containing numerous figures. 'Methods of Study in Natural History.' By L. Agassiz. Boston, 1863. Originally delivered as oral lectures, and reported in the 'Atlantic Monthly.' In the Proceedings of the American Academy of Arts and Sciences, vol. v., 1860–1862,—"Atomic Weight of Antimony." In the Proceedings of Academy of Natural Sciences of Philadelphia,' January to July, 1863,—"Descriptions of Fossils from the Yellow Sandstone lying beneath the 'Burlington Limestone' at Burlington, Iowa." In the Proceedings of Boston Society of Natural History,—"Map of North America, illustrative of the Distribution of Land-Shells." By Mr. W. G. Binney. "On the Fossil Crab of Gay Head." By Mr. W. Stimpson. "On the Reptile Bird of Solenhofen." By L. Agassiz. "On the Geographical Distribution of the Sea-Urchin of Massachusetts Bay" (*Echinus granularis*). By A. Agassiz. "Cast of Megatherium set up at the Museum of Comparative Zoology, Cambridge, U.S." By L. Agassiz. "Zircon, Corundum, and other Minerals from Greenwood, Me." By A. E. Verrill. "Copper-bearing Belt of Canada East;" and "On the Magnesian Limestone of the Lower Silurian series of Prairie du Chien containing Crinoids and Fossil Shells." By C. T. Jackson.

REVIEWS.

The School Manual of Geology.

By J. Beete Jukes, M.A., F.R.S., Local Director of the Geological Survey of Ireland. Edinburgh: A. and C. Black. 1863.

If we think it beneath the dignity of Mr. Jukes's position to write school manuals, and regret the time spent on such trivial labours by a man so capable of better work, it is because, having attained to his present rank, and to the command of such powerful resources as fall within the grasp of a director of an extensive portion of the British Islands, we had hoped to see his whole time occupied in working out the material at his command, in a manner alike redounding to his own fame and to the advance of science. We have made the like comments on the popular books of other eminent Government servants, and therefore these are not meant as personally unkind towards Mr. Jukes; indeed, we are quite willing to admit that the book before us is a very nice one, and far more sensible than we anticipated from the title or from the preface when we read in it that "this little book is intended for the use of young persons of fourteen or fifteen years of age." The preface, however, further informs that "it is also offered to grown-up persons who have no time for a more extended study of the science, with the hope that they may gain from it a fair general notion of the scope and nature of that science." The chief difficulty, Mr. Jukes fancies, "the learner meets with in the study of geology, is the want of elementary knowledge of the collateral sciences of physics, chemistry, mineralogy, zoology, and botany," and he thinks, if these sciences were made part of our ordinary education, as they ought to be, it would be easy to teach their application to geology. We do not agree with him. The first great impediment to the propagation of geology is the want of logic and want of certainty of many of its principles; it has not the same certainty of conclusion as mathematics, it has not the self-evidence of experiments in chemistry, it possesses neither analysis nor synthesis, and it wants the efforts of our best men to give its tottering framework solidity. The older workers have thrown in such a lot of rubble, and although geologists have laboured much, it has been isolatedly and independently, every man casting his stone on the rising walls as a passer-by would on a Scotch cairn, until the edifice has risen to lofty height, but without sufficient adhesion. There is material enough for the rough work of the cyclopean building, but it is as rude as the unhewn-stone forts of ancient Northumberland, and the cement and the facing-stones are wanted to complete its strength and the fineness of its finish. There are other difficulties barring the general study of geology, time and money,—time to examine over extensive territories, money to defray the expenses of travel and of collecting. Local geologists working out special areas and subjects may be numerous; experienced geologists ever must be few. No men possess greater advantages for obtaining and elaborating some at least of the required facing-stones of the huge superstructure of geology than the Directors of National Surveys, no other men have the means at their disposal in time, money, or assistance, still less of obtaining the intercommunication with foreign surveys; but instead of grand works such as Agassiz' 'Fossil Fishes,' Hutton's 'Coal Plants,' Owen's 'Odontography,' D'Orbigny's 'Palæontology of France,' Mallet's 'Earthquake Phenomena,' and the publications of the Palæontographical Society, we must be content to buy for our children the "little books" which those great men we wish to look up to, write for our publishers. Luckily, we have no reason to dread a Murchison penning a geological primer for infant schools.

But to take the book as it is, and to view it as one for those who have not time for much study, it is better calculated to give the best running notion of geology with the least amount of trouble of any book we know. The popular doctrines of geology are fairly and moderately put, and although adhering to many of the views which we ourselves have shown a strong antagonism to in the pages of this journal, Mr. Jukes puts them fairly, and, for a school treatise, properly. Such a work is not an arena for controversy, nor would it be fitting in it to go too strongly against the stream of general belief, and it is therefore better and wiser to teach what is generally accepted, and when to that which is not certain the author adds a statement to that effect, he has done all that is required of him. This Mr. Jukes does most fairly, according to his conscience. Take the account of the igneous rocks as an example, on which, after stating the grounds which geologists urge for a molten state of the interior of the globe, and showing that if the temperature increased regularly with depth, as it is supposed to do, say 1° F. for every 100 feet, or 52° F. for every mile, that at four miles deep water would be at boiling-point, at fifty miles the heat would be sufficient to melt steel, and that at a hundred miles the temperature would be 5000° F., which, Mr. Jukes says, is "greater than any that we know at the surface."

"It is not by any means necessary, however, to suppose that the temperature does increase indefinitely into the interior, or that the rate which regulates its increase near the surface continues to be the same for such depths as those mentioned above. Neither does it follow that the materials, whatever they may be, which exist at great depths, would be melted by the same amount of heat that would fuse them at the surface, since the enormous amount of pressure which they must experience, may keep them solid in spite of the heat."

After this usual supposititious evasion of the discussion of the great difficulties attending the "molten interior" doctrine, Mr. Jukes praiseworthily adds a concluding sentence to his chapter:—

"Little or nothing," he says, "is known about the constitution or condition of the interior, nor have we any grounds even for speculation, further than those which have been previously mentioned."

The same moderate expression of views of which we have given an example from the first pages, continues throughout to the end, and from the last page we take another similar extract:—

"The term 'transition' was at one time used to designate an imaginary period between that of the formation of the so-called crystalline rocks and the others. Part of the same prejudice still lingers amongst geologists, and induces them to regard the present time as distinct from the Tertiary epoch, and to introduce such terms as Post-Tertiary or Quaternary."

For those who want to get a fair running knowledge of geology with the least amount of trouble, Mr. Jukes's book will be just the thing. We think highly of Mr. Jukes's ability, and we wish it had been a great work, or a small work on some special topic,—something, in short, beyond an elementary treatise going all over the old ground,—that we might have spoken as much kind praise as we have every pre-existing desire to give to any meritorious labours that emanate from any of the Survey men.

The Flora of Marlborough. By T. H. Preston.

With Mr. Preston's *brochure* as a Flora we may have, seemingly, little to do, but there is an important connection between the plants of a district and the soil on which they grow. This soil may not be necessarily the débris or the resultant of the weathering and atmospheric degradation of the true geological strata of the district, and indeed it may be, as it very often is, formed from a superficial covering of the drifted and over-covering materials of a later and long subsequent age to that of the underlying rocks to which the main outlines of the physical geography are due. Botanists have perceived this relationship, and although they must necessarily regard it in a different light, we find that in local, and even in general Floras, considerable attention is now paid to the geological features of the district or country under botanical description. In this manner the geology of Marlborough is set before us in the little volume we are reviewing, before even the flowers of the region are recorded. This survey of the botanist is especially useful in its way to the practical geologist, because it investigates the superficial covering of the earth in a manner in which he would be little likely to do, and yet not the less important, as by it we obtain a knowledge of the workings of external agencies upon the ground that produces vegetation. In the neighbourhood of Marlborough, we are told that the surface for miles round, and to a great depth, has been entirely formed by these external agencies; the Kennet, as an example, we are told, has at Lockeridge, only four miles from its source, filled up one of its former courses, and made a new track for itself through the marshy ground. On the northern side of the Kennet, the country consists almost entirely of Upper Chalk, with a few outlying patches of red clay on the tops of the hills. In a wood to the north of Mildenhall, there occurs a red stratified clay, more than twelve feet in thickness. About four miles east of Marlborough, on the ridge by the Kennet, there is a vertical fault running nearly north and south; the western side being occupied by horizontal layers of Upper Chalk with flints, and the eastern by a reddish-brown sand, containing flint pebbles up to a pound in weight. Between Graham Hill and Martinsell the chalk is stated to be covered by boulder-clay, which is said also to extend westward as far as Clatford Bottom, and probably to form the subsoil of the greater part of the west woods, and on the eastward runs into Savernake Forest. In the valley to the south of Granham Hill there is a strip of light-coloured sandy clay overlying the chalk, and to the south of this what is called "a mottled red boulder-clay," containing large masses of flint-nodules and sandstone boulders. Near the top of the chalk slope at the north-west corner of the forest there is a trough-like hollow in the chalk, five-and-twenty feet wide and eight feet deep, fitted up with layers of red clay with large broken flints and chalk rubble, and thickly studded with "two kinds of fossil shells of the genus *Helix*, which very much resemble *H. occlusa*, and a smaller species, *H. d'Urbani*, some of which are beautifully marked. This hollow may have been the course of a river during the time of deposition of some of the later Tertiary beds; and a flood probably swept into the layers of broken fragments of chalk and clay, together with the numerous land-shells with which they are studded." About 300 or 400 yards from the spot is a light buff-coloured sand, and on the south side of the pit are hardened blocks of sandstone. The writer thinks this sand was once a part of the Plastic Clay series, at one time covering the district, and of which there are said to be still some remains in the south-east part of the forest. This appears to be, according to the subsequent description, a section showing the "grey weathers" *in situ*. These "boulders" are stated to occur in great numbers in the valleys, especially at Lockeridge and Clatford Bottom, "where they are heaped upon one another in the most promiscuous manner, as if they had been dropped by icebergs." Many are of large size, 90 to 100 tons. An outline of the Bagshot sands and clays also occurs in the Savernake Forest. Of the flora we can only say that it is conspicuously and concisely recorded in separate paragraphs, with bold headings, and is substantially upon the plan adopted by Professor Babington for his 'Flora of Cambridge.' The book is illustrated with a small photographed map of the district, reduced from the ordinary 1-inch survey to within the space of a double page. It wants a scale to indicate distances, and this might be usefully added.

Philosophical Transactions of the Royal Society. Part I. Vol. CLIII. 1863.

This part is a highly important one, containing papers "On the Relation of Radiant Heat to Vapour," by Professor Tyndall; "On the Strains of the Interior of Beams," by the Astronomer Royal, Mr. Airy; "On the Reflection of Polarized Light from Polished Surfaces, Transparent and Metallic," by the Rev. Professor Haughton; "On the Exact Forms of Waves near the Surface of Deep Water," by Dr. Rankine; "The Photo-Chemical Researches of Professors Bunsen and Roscoe;" "On the Immunity of the Stomach from Injury from its own Secretions," by Dr. Pavy; "On Thallium," by Mr. Crookes; and other very valuable papers; but the chief interest to our readers will be the appearance in it, in full, of Professor Owen's memorable paper, read in November, 1862, and briefly reported in our columns. The present memoir is perhaps the most complete that ever was given at first hand of any specimen approaching in novelty and singularity to the present Solenhofen fossil, a drawing of which is given of natural size, executed with great care and skill by Mr. Dinkel. Other illustrative plates accompany the paper, which must be read by those who are interested in the subject, as no abstract would convey more information than the notices and articles we have already printed; and the greatest value of Professor Owen's description lies in the minuteness and details of the numerous comparisons he has made with the bones of recent birds and fossils, Pterodactyles, and the logical conclusions he has deduced from them. The Professor admits the cast of the brain, to which we drew attention in our opening number of last year; but he assigns to a fish a portion of organic substance in the slab upon which Mr. Mackie has made some comments in the 'Popular Science Review,' for the purpose of showing that it is as like a bird's beak with teeth as a fish's jaw. The portion is, however, too obscure for any positive determination, and it will be better not to believe it either a fish's jaw or the Archæopteryx beak at present, but to continue to search diligently for further specimens.

THE GEOLOGIST.

FEBRUARY 1864.

WORK FOR THE FIELD-CLUBS.

BY THE EDITOR.

WITHOUT the slightest wish to interfere with the management, or any desire to criticize the past doings of Natural History Societies and Field-Clubs, we may be permitted, without any imputation of meddling, to suggest how much good work the forthcoming year may produce, through a little forethought and pre-arrangement. Spring-time will now soon be upon us, and the time for field-excursions will have come on again. Would it not be well if the Councils of Societies organized their arrangements with a view to some practical ends?

In the districts of crystalline and metamorphic rocks, examples of transitional states bearing on the great origin-of-granite question might be designated as one of the topics of inquiry, and members solicited to search for and study examples, and to send notices of them to the Societies before the excursions were decided upon. In the districts of the Secondary rocks, examples of unconformability and thinning out, and the intercalation of special deposits, would also form a most valuable subject of inquiry.

Palæontology, as such, should not be neglected: and by selecting given genera or families of fish, mammals, or mollusca, and tracing the ranges of species upwards and downwards stratigraphically through the separate beds of the various deposits of any geological formation or formations, the most valuable data for geological progress would be obtained; and contemporaneously with this investigation, another, devoted to the geographical extent at each horizon of the same species, should also be carried on.

In the districts affected by the late earthquake the directions so intelligently given by Mr. Mallet might be taken as the guide to local inquiry, and many details accumulated.

More especially we would urge that as much impetus as possible should be given to fossil botany. It is a department sadly neglected, and nevertheless most useful and most important in the acquirement of a correct knowledge of the ancient history of our planet. In the mining districts further experiments on internal heat are greatly to be desired.

We do not submit to the Provincial Societies the organization of special subjects for investigation during these excursions, but the detailing to the members of certain subjects for individual study and attention, and to get from the working members who take such subjects up reports of their progress, and the details of the most interesting examples and results; and then upon these reports to select the places for, and the routes of excursions, making the principal or most competent of the working members the *duces* on these occasions. We think that by such preliminary steps the excursions would be made much more instructive, more pleasurable, and certainly more beneficial to science.

ON HELIX, AND PERFORATED LIMESTONE.

By Miss E. Hodgson.

A few months ago I sent to the British Museum a block of mountain limestone, perforated into deep cells by mollusks. It was met with on a limestone ridge three miles south-west of Ulverston, and first attracted notice by being brought to town to be employed for building purposes.

The perforations were found to be on the under-side of a projecting ledge, and were large enough for the fingers to be introduced upwards to the depth, in some, of three inches, the diameter being about seven-eighths of an inch. They were inhabited, at the time of the discovery (August), by the land-snails *Helix nemoralis* and *Helix concinna.*

Mr. Woodward, on receiving the stone, very kindly sent for my perusal a 'Memoir on Perforations by Helices in the Calcareous Rocks of the Boulonnais,' by M. Bouchard-Chantereaux. In this memoir the author states his belief that the cells are the work of

Helices, and that the eroding action is performed by the foot, with the aid of an acid secretion.

Ever since I became familiar with the microscopic structure of the tongue of Helix, etc., I have always believed that it was so constructed for purposes of abrasion, either of stone or other hard substances; but I was not previously aware that the land-snails were, any of them, supposed to form for themselves hollowed, hybernating chambers in rocks. That they do consume the limestone no one who has seen the above memoir can doubt; the only thing not so evident is the way it is done and the purpose for its being done.

Finding some individuals of *Helix aspersa* under a stone in a hybernating state, I had the stone and all carefully placed under a bell-glass in a warm room, leaving sufficient space under the edge of the glass for air. The following morning all had burst the epiphragm and shifted their position. In another day they were all upon the glass, in full activity, crawling about. On examining the under-side of the head through the bell-glass with a lens, no tongue was visible, but on smearing the glass with the juices of bruised geranium leaves, the tongue protruded itself, making strokes upon the glass at the rate of about one in three or four seconds. I then scraped a piece of limestone with a pen-knife upon a sheet of paper, and moistened the scrapings into a paste with distilled water, and then smeared the inside of the glass with the paper. The action of the tongue hitherto had been sluggish and not continuous, but the instant the head came in contact with the lime the action quickened. Flake after flake was removed from the glass and taken into the crescent-shaped mouth. The tongue appeared to be used nearly in the same way as that of the pond-snail when it is taking off the green film from the sides of the aquarium; that, however, is accompanied by a clear, ringing sound, doubtless owing to the necessary force used. In Helix the tongue is curved outwards and first pressed momentarily, more or less flat, against the glass, the next instant it becomes channeled or spoon-shaped, and in this form is withdrawn, the concave side uppermost. I have no doubt, however, on a dry substance, one not so slippery as glass, that the flat application would be prolonged, and more muscular force exerted,—indeed I have occasionally observed a slight jerk of the head as the tongue left the glass, indicating greater power of stroke.

On subsequently trying *Helix nemoralis*, it swallowed the lime with the same avidity, and both worked at it, with short intervals of rest, for hours and day after day. In both species a little wave of moisture is driven before the head, extending beyond it about the fiftieth part of an inch; but the tongue appears to be drier in *H. nemoralis* than in *H. aspersa*, although I think the amount of fluid varies in both. When the animal is merely gliding along, and not using the tongue, a little bubble of fluid is constantly, at short intervals, emitted from the mouth, which partially opens for the purpose. I have repeatedly saturated strips of litmus paper in this fluid, both at the head and all along the foot, but have entirely failed to detect any pink colouring denoting the presence of an acid.

When the tongue is being withdrawn into the mouth it does not seem to touch the upper jaw, but has full time to be withdrawn before the upper jaw closes; indeed it does not seem to close entirely, the downward movement appears to be more connected with the action of swallowing than made for the purpose of meeting the tongue. On putting a little water to the animal, of which it seems to be very fond, the drinking action is seen to be different. I do not think the tongue is protruded, but there is a rapid movement of the whole mouth until the supply fails, when the tongue again comes into play.

Desirous of witnessing the usual mode of feeding, I placed some slices of the fronds of *Asplenium marinum* on the glass. The *H. aspersa* attacked and devoured this very greedily. It was curious to watch the upper jaw, before so inactive, now making such strenuous efforts to get it into the mouth; the latter was distended to a gape, displaying the interior brown ribs of the roof and its projecting marginal teeth; the tongue, when I could see it for the fern, was actively assisting. It was a very awkward process, the piece being too big and difficult to manage.

From these observations it appears certain that the mouth has two distinct actions—the licking and the biting action. It also appears equally certain that lime is needful to the animal, and is taken in the same way as food; from which I infer that the Helices, when they are occupying the cells in the limestone rocks, abrade the walls with the tongue for the purpose of getting the lime (and that they hold this instinct in common with the rest of their species), hence the irregularity, dissimilarity, deformity of those cells much frequented by them; but that the original cellular form of the erosion is due to some marine mollusk of the Glacial period.

A HELP TO THE IDENTIFICATION OF FOSSIL BIVALVE SHELLS.

By Harry Seeley, F.G.S.,
Woodwardian Museum, Cambridge.

Lamellibranchiate shells are the most abundant fossils of most rocks. Numerous in genera, and prolific in species, they are multitudinous in individuals, and the specimens vary. The study is not easy. It has little of the poetry of many other branches of natural history, and has naturally received less attention. But in each subkingdom specially, no less than in the animal kingdom generally, the law holds good that the lower the organization the longer is the duration in time. And so, important as the higher mollusca are in the analysis of rocks into their several zones, it is on the lower forms we rely in synthetical arrangements. The Conchifera readily divide rocks into Palæozoic and Neozoic,—no form with a pallial sinus being known below the Lower Secondary strata; while, from the appearance in them of numerous new genera, no class of animals better marks the recognized systems into which fossiliferous rocks are grouped. It is indispensable both to the geologist and biologist to be familiar with the genera, and it is the object of this paper to render the principles on which they are identified more easy and exact.

That genera are *practically* realities every student knows well; as such the geologist and zoologist have to do with them. And it has elsewhere* been shown that between hosts of groups intermediate forms can no more be found, than can intermediate wood fill the space between the forked branches of a bush. Accepting the fact, the question arises,—How may genera be known? The distinctive characters depend on the definition of a genus adopted. If it is merely a number of nearly-related species, then the descriptive characters will include those in the whole of the forms; but if it exists independently of the species, being fundamental to them, then the specific characters cannot enter into the description of the genus. Practically this latter view, which is adopted in the paper referred to, reduces the description to a sixth of the shortest customary length; while the distinction becomes clearer by pruning away much that is common to other types. But even these characters are often needlessly redundant, and several common to nearly-allied groups may be cancelled.

Having in this spirit examined an extensive series of Lamellibranch shells in preparing for a course of lectures, given three years ago, I found in most cases the hinge-characters among the most important residua so gotten; and shortly after, while determining some casts of fossils in which the hinge-teeth were the only generic characters seen, it occurred to me to write the teeth down in formulæ like those used for the teeth of mammalia. Subsequent re-examination of specimens showed that in a large majority of cases these hinge-formulæ were almost the only characters with which the student need be troubled; and believing that it will not be found altogether useless, the following list has been made of the more common and remarkable forms, and arranged for facility of reference.

The teeth sometimes vary much in the same genus,—one Cardium, for instance, showing twelve teeth, and another not more than six; though rudiments of the other six may generally be found; and occasionally the hinge is toothless, the teeth becoming obliterated with age. The constant teeth are notated in ordinary numerals;

* 'Researches on the Homologies of the Bivalve Mollusca; and therein of the Law of Variation of Forms, and the Nature of Genera,' Part 1, communicated to the Cambridge Philosophical Society, March 17, 1862, and remaining unpublished, pending completion. The formulæ used in this paper were then explained in a note.

while the variable ones, which sometimes may be as large as the others, and are sometimes scarcely to be found, have a line or dot above the numerals to indicate that they are subordinate. Teeth are often cleft a little, and sometimes look like two, so that it is occasionally convenient to indicate them in the formula, which is done by writing a small figure ^{2} above the numeral, as though it were raised to the second power.

Rarely teeth are anchylosed, but, excepting Isocardia, only under the umbones, and then only at their outer edges, forming an inverted V shape, which is indicated by a small figure ^{1} placed above the numeral 2.

Typically, teeth are in three groups: those under the umbo, called umbonal; those near the front adductor muscle, called anterior; and those under the ligament, called posterior. These two latter groups are often elongated latitudinally, and when this is the case have a small *l* added to distinguish them from the ordinary conical forms.

The spaces between the groups of teeth on each side of the umbo are generally equal, and such spaces are marked by a single dot placed midway between them. To indicate a longer distance, two dots may be put one after the other, and a very short one is marked by two dots one above another.

For a cartilage-pit the letter F is used (abbreviation of *fossa*), and where a tooth has the letter *f* above it, the tooth supports the cartilage, as in Mya, etc.

The sign + means many; it is chiefly used to indicate the numerous teeth of the Arca tribe. The straight line running between the numerals marks the plane dividing the valves. The letter S is an abbreviation for "with a pallial sinus;" L, for lunule; E, with an escutcheon; O, with an ossicle; M, massive; and Q, quadrate.

The teeth are read from left to right, the posterior end being to the right,—so that the lower valve is *not* the left.

As an illustration of the way these symbols are used, an example or two may be cited.

TRIGONIA.—Here there are in the lower valve two teeth under the umbo, and no anterior teeth, so the number 2 is written under a line and with a dot on each side to show that the teeth are umbonal, thus $\frac{\quad}{\cdot 2 \cdot}$. Then in the upper valve there is on the left a single tooth, and to the right of it two anchylosed; and as these are under the umbo, they, too, are written with the dot on each side, thus: $\frac{\cdot 1 : 2^1 \cdot}{\quad}$. Putting these valves together, the generic characters for Trigonia will be $\frac{\cdot 1 : 2^1 \cdot}{\cdot \; 2 \; \cdot}$, and as no other genus has teeth quite like it, obviously no other character need be mentioned. It is found convenient, in remembering these formulæ, to prefix the initial letter of the genus.

CRASSATELLA.—Here the upper valve has two teeth and a cartilage-pit under the umbo, and posteriorly one tooth; so the dentition will be $\frac{\cdot 2 : F \cdot 1}{}$. And in the lower valve under the umbo are two teeth and a little subordinate one (constant however), and the cartilage-pit; its formula will therefore be $\frac{}{\cdot 2\underline{1}F\cdot}$. Putting the valves together, $\frac{\cdot 2F.1}{\cdot 2\underline{1}F\cdot}$, will be the generic character for Crassatella; and no other genus has a like hinge.

LIST OF GENERIC FORMULÆ.

Types with a single Cartilage under the Umbo: F.

Anomia .	$\frac{\cdot F\cdot}{\cdot F\cdot}$; with four central muscular impressions.	Pecten . .	$\frac{\cdot F\cdot}{\cdot F\cdot}$; axis perpendicular to a straight hinge line.
Ostrea . .	$\frac{\cdot F\cdot}{\cdot F\cdot}$; attached.	Mya . . .	$\frac{\cdot 1/\cdot}{\cdot F\cdot}$; S.
Lima . . .	$\frac{\cdot F\cdot}{\cdot F\cdot}$; axis anteriorly inclined to a straight hinge line.*	Tugonia .	$\frac{\cdot 1/\cdot}{\cdot 1/\cdot}$; S.

§ *With an Ossicle in the Cartilage: O.*

Thracia .	$\frac{\cdot F\cdot}{\cdot F\cdot}$; O; S.	Anatina .	$\frac{\cdot 1/\cdot}{\cdot 1/\cdot}$; O; S.

Types with Teeth in addition to the Cartilage.

Chamostrea	$\frac{1\cdot F\cdot}{1\cdot F\cdot}$; O.	Mesodesma	$\frac{1\cdot 1F\cdot 1}{\underline{2}\cdot 1\underline{1}F\cdot 1}$; S.
Avicula .	$\frac{1\cdot F\cdot \bar{1}'}{1\cdot F\cdot \underline{1}'}$	Crassatella	$\frac{\cdot 2F\cdot 1}{\cdot 2\underline{1}F\cdot}$; L.
Anapa . .	$\frac{1\cdot 1/\cdot 1}{1\cdot 1/\cdot 1}$	Lutraria .	$\frac{\cdot \bar{1}1^{2}\bar{1}F\cdot}{\cdot 2^{1}F\cdot}$; S.
Ervilia . .	$\frac{\cdot 1F1\cdot}{\cdot 1F1\cdot}$	Mactra .	$\frac{2'\cdot 2^{1}F\cdot 2'}{2'\cdot 2^{1}F\cdot 2'}$; S.
Plicatula .	$\frac{\cdot 1F1\cdot}{\cdot 1:F:1\cdot}$; attached.	Codakia .	$\frac{2\cdot 2F\cdot 1}{1\cdot 2F\cdot 1}$.
Spondylus	$\frac{\cdot 1F1\cdot}{\cdot 1:F:1\cdot}$; umbo of attached valve receding with age.	Scrobicularia	$\frac{\cdot 2F\bar{1}\cdot 1}{\underline{1}\cdot 1\underline{1}F1\cdot}$; S.
Gnathodon	$\frac{2\cdot F\cdot 1}{3\cdot F\cdot 2}$; S.	Semele . .	$\frac{1\cdot \bar{2}F\cdot 1}{1\cdot 2F\cdot 1}$
Cardinia .	$\frac{\bar{1}\cdot F\cdot 1}{1\cdot \underline{1}F\cdot \underline{1}}$	Ungulina	$\frac{\cdot 2\bar{F}\cdot}{\cdot 2F\cdot}$

* The direction of the axis might be marked by a line; thus, Lima /; Pecten |; Avicula \.

Types with many Cartilage-pits.

Gervilia . $\frac{\cdot F^{a}\cdot\cdot +}{\cdot F^{a}\cdot\cdot +}$

Perna* . $\frac{F : +}{F : +}$

Types with numerous Parallel Teeth.

Macrodon $\frac{(1 : +' 1 : +)\cdot 1'}{(1 : +' 1 : +)\cdot 1'}$

Arca . . . $\frac{1 : +}{1 : +}$; hinge straight.

Cucullæa $\frac{1 : +'\cdot 1 : +\cdot 1 : +'}{1 : +'\cdot 1 : +\cdot 1 : +'}$; muscles margined by lamellæ.

Pectunculus $\frac{1 : +}{1 : +}$; hinge crescentic.

Limopsis. $\frac{1 : + F\cdot 1 : +}{1 : + F\cdot 1 : +}$

Nucula† . $\frac{1 : +\cdot F\cdot 1 : +}{1 : +\cdot F\cdot 1 : +}$; hinge sharply angular at F.

Nuculina $\frac{1 : +\cdot\cdot 1'}{1 : +\cdot\cdot 1'}$; hinge angular.

Leda . . . $\frac{1 : +\cdot F\cdot 1 : +}{1 : +\cdot F\cdot 1 : +}$; S.

Solenella $\frac{1 : +\cdot\cdot 1 : +}{1 : +\cdot\cdot 1 : +}$; S.

Types with few Teeth under the Umbo.

Chama . . $\frac{\cdot 1\bar{1}\cdot}{\cdot 1\cdot}$

Pholadomya $\frac{\cdot\bar{1}\cdot}{\cdot\underline{1}\cdot}$

Iphigenia . $\frac{\cdot 1^{2}\cdot}{\cdot 1^{2}\cdot}$

Psammobia $\frac{\cdot 1\cdot}{\cdot 2\cdot}$; S.

Astarte . $\frac{\cdot 2\cdot}{\cdot 1\cdot}$; L.

Opis . . . $\frac{\cdot 2\cdot}{\cdot 1\cdot}$; L; keeled.

Pachyrisma .. M $\left(\frac{\cdot 1\cdot}{\cdot\bar{1}1\cdot}\right)$

Gastrana. $\frac{\cdot 1^{2}\cdot}{\cdot 2\cdot}$; S.

Capsula . $\frac{\cdot 1^{2} : 1\cdot}{\cdot 1 : 1^{2}\cdot}$; S.

Sanguinolaria $\frac{\cdot 2\cdot}{\cdot 2\cdot}$; S.

Pharus . . $\frac{\cdot 2\cdot}{\cdot 1 : 1^{2}\cdot}$; S.

Solecurtus $\frac{\cdot 2\cdot}{\cdot 2\cdot}$; S; both ends gaping.

Saxicava . $\frac{\cdot 2\cdot}{\cdot 2\cdot}$

Diplodonta $\frac{\cdot 1^{2} : 1\cdot}{\cdot 1 : 1^{2}\cdot}$

Venericardia $\frac{\cdot 2\cdot}{\cdot\underline{1}1\underline{1}\cdot}$

Trigonia . $\frac{\cdot 1 : 2^{1}\cdot}{\cdot 2\cdot}$

Lucinopsis $\frac{\cdot 1 : 1^{2} : 1\cdot}{\cdot 2\cdot}$; S.

Circe . . . $\frac{\cdot 3\cdot}{\cdot 3\cdot}$; L.

Venus . . $\frac{\cdot 3\cdot}{\cdot 3\cdot}$; L; S.

Tapes . . $\frac{\cdot 3\cdot}{\cdot 3\cdot}$; S.

Glaucomya $\frac{\cdot 3\cdot}{\cdot 2 : 1^{2}\cdot}$; S.

Saxidomus $\frac{\cdot 3\cdot}{\cdot 4\cdot}$; S.

Cytherea $\frac{\cdot 4\cdot}{\cdot\underline{2}3\cdot}$; L; S.

Artemis $\frac{\cdot 4\cdot}{\cdot\underline{2}3\cdot}$; L; S; orbicular; sinus an elongated cone.

* In this genus should be included all the fossil species called Inoceramus, excepting perhaps *I. involutus*, which may be left as a critical subtype, having much the same relation with Perna that Janira has with Pecten.

† The Palæozoic species of Nucula and Leda have external ligaments, and are regarded by authors as then forming one genus, which is named Ctenodonta.

Types with Umbonal and Posterior Teeth.

Panopæa . $\frac{\cdot 1 \cdot 1^{\prime q}}{\cdot 1 \cdot 1^{\prime q}}$

Margaritina $\frac{\cdot 1 \cdot 2}{\cdot 1 \cdot 1}$

Hippopus $\frac{\cdot 1 \cdot 2}{\cdot 1 \cdot 2}$

Tridacna . $\frac{\cdot 1\overline{1} \cdot 1\overline{1}}{\cdot 1 \cdot 2}$; lunule perforate.

Ensis* . . $\frac{1 \cdot 2}{1 \cdot 2}$; S.

Solen . . $\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 1}$; S; umbones terminal.

Cultellus $\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 1}$; S.

Machera . $\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 1}$; S; from umbo to base runs an internal rib.

Tancredia $\frac{\cdot 2 \cdot 1'}{\cdot 2 \cdot 1'}$

Castalia . $\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 2}$

Unio . . . $\frac{\cdot 2 \cdot 2'}{\cdot \underline{1}\, 1 \cdot 1'}$

Cyprina . $\frac{3 \cdot \overline{1}}{\overline{\underline{1}}\, 3\, \underline{1} \cdot 1}$

Types with Anterior and other kinds of Teeth.

Cardita . $\frac{\overline{1} \cdot 1 \cdot 1'}{\underline{1} \cdot 1' \cdot \underline{1}'}$

Kellia . . $\frac{1' \cdot 1 \cdot 1'}{(\underline{1}\, 1)' \cdot 1 \cdot (1\, \underline{1})'}$

Isocardia $\frac{(1 \cdot 1)'' : 1' \cdot 1'}{1 : (1 \cdot 1)'' \cdot 1'\, \underline{1}}$

Cardium . $\frac{1\, \overline{1} \cdot 1\, \overline{1} \cdot 1\, \overline{1}}{\underline{1}\, 1 \cdot \underline{1}\, 1 \cdot \underline{1}\, 1}$

Tellina . . $\frac{\overline{1} \cdot 1^{2}\, \overline{1} \cdot \cdot 1}{\overline{1} \cdot \overline{1\, 1^{2} \cdot \cdot 1}}$; S.

Galatea . $\frac{1 \cdot \quad \cdot 1}{\underline{1} \cdot 2^{1} \cdot \underline{1}}$; S.

Donax . . $\frac{1 \cdot 2 \cdot 1}{\underline{1} \cdot 2^{1} . \underline{1}}$; S.

Lucina . . $\frac{1 \cdot 2 \cdot 1}{1 \cdot 2 \cdot 1}$; L; S.

Corbis . . $\frac{1 \cdot 2 \cdot 1}{1 \cdot 2 \cdot 1}$; margins crenulated.

Cyclas . . $\frac{1 \cdot 2^{1} \cdot 1}{1 \cdot 2 \cdot 1}$

Cyrena . $\frac{1 \cdot 3 \cdot 1}{\underline{1}\, 1 \cdot 3 \cdot 1\, \underline{1}}$

Corbicula $\frac{1' \cdot 3 \cdot 1'}{(\underline{1}\, 1)' \cdot 3 \cdot (1\, \underline{1})'}$

Trigona . $\frac{1 \cdot 3 \cdot}{\underline{1}\, 1 \cdot 3 \cdot \underline{1}}$; S.

Meroë . . $\frac{1 \cdot 3 \cdot}{\underline{1}\, 1' \cdot 3 \cdot}$; L; E; S.

Many of the formulæ will be found unsatisfactory, no doubt; for it has not been my object either to give a synopsis of bivalve genera or of generic characters, but merely to illustrate the features and capabilities for distinctive purposes of some remarkable mystical structures. Yet I would ask the student who takes some member of one of the larger types, say Donax, Tellina, Cardium, or whatever it may be, and fails to torture its hinge into agreement with the formula, fairly to ask,—What a genus really is? Unless I mistake, facts are as faulty as the formulæ. This, however, involves the whole question of the nature and origin of genera, which will shortly be treated in full elsewhere.

* A form like this is not introduced as a genus, but merely as an illustration of results arrived at by adhering to the formulæ rigidly.

These characters ought never to supersede descriptions, but should rather be superadded. And it is suggested that, henceforth, definitions might be made more sure if the dental formula were given with each new species or genus described. And, by way of illustration, annexed is a notice of the new genus Atalanta.

Atalanta has but one species, and is founded on the *Astarte Hartwelliensis* of Sowerby. Observing on it a posterior area like that in Cyprina, and which also occurs in some species of Astarte, which show rudiments of lateral teeth, I was led to suspect that if this shell were an Astarte at all, it also might have lateral teeth. Accordingly, as there was no lack of specimens, I broke up many examples, and succeeded in finding the hinge, which is $\frac{1' \cdot 2 \cdot 1'}{(1\,1)' \cdot 1 \cdot 1'}$; thus differing from Astarte in having on each side well-developed lateral teeth. The long teeth give it a certain resemblance to Corbicula or Mactra, which it also resembles in having the lateral teeth transversely striated with age. The ligament is short, but very prominent. The pallial line was not to be traced. Astarte is probably its nearest relative.

FOSSIL BIRDS.

BY THE EDITOR.

(*Continued from page* 24.)

We shall, we trust, be pardoned for returning in this number, before we proceed onwards to Cuvier's works, to some omissions of old authors which have occurred.

The first of these additional quotations is from Scheuchzer's later work, published at Zurich in 1718, 'Meteorologia et Oryctographia Helvetica,' p. 336.

"DILUVIAN BIRDS.—Everybody can very easily conceive that all the birds, owing to their agility, could have escaped the waters of the Deluge, and it is therefore not to be wondered that even in the richest and best-assorted museums of arts and natural history, remains of the bird-kind are very seldom to be met with, or that they are, so to say, scarcer than a white raven. In Switzerland I have as yet found nothing; from the quarry of Oeningen I can show a well-impressed bird's feather, which I have reproduced on page 14 of the Querel. Pisc." This figure we give in our Plate IV. fig. 1.

The original passage follows below:—

"AVES DILUVIANÆ.—Es kan ein jeder ohnschwer begreifen, dass die Vögel, wegen ihrer Leichte, alle werden in denen Sündfluth-Wassern oben aufgeschwummen seyn, und sich desshalb nicht zu verwundern, wann auch in denen best-versehenen Kunst- und Naturalien-Kammern etwas von dem Vogel-Geschlecht überbliebenes so seltsam oder noch rarer ist als ein

PLATE IV.

Fig. 1

Fig. 2.

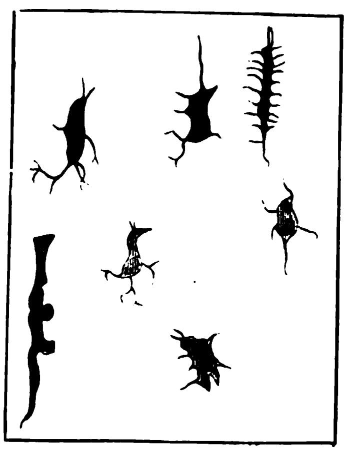


Fig. 3.

FOSSIL BIRDS, FROM SCHEUCHZER (Fig. 1), CUVIER (Fig. 2), AND EMMONS (Fig. 3).

weisser Rab. In denen Schweitzerischen Landen habe noch nichts gefunden; aus den Oeningischen Steinbruch aber kan ich zeigen eine wol ausgedruckte Vogelfeder, welche habe abbilden lassen in Querel. Pisc. p. 14."

Volkmann, in 1720, published his 'Silesia Subterranea,' at Leipzig. In it he says:—

"§ VI. All these phases are common also with birds, insects, worms, and vermin. Mylius, in his Memor. Sax. Subterr. pl. i. relat. vi. p. 47, records a hen, which was discovered a few years ago in the quarries of Illmenau, and which he exhibits on plate iv. n. i. p. 74, such as it is to be seen in the stone.—Baccius reports in his 'Thermis,' lib. v. c. 4, fol. 282, having seen a petrified hen together with her eggs, discovered in a salt-pit.—Valvasor, according to what he says in his description of the principality of Crain (die Ehre des Herzogthums Crain), lib. iv. c. 2, p. 478, discovered near Landespreis, in a ditch, on the mountain, amongst many sea-shells and other petrefactions, a bird's nest with a small bird sitting on four eggs, which he presented to M. Henry Garbusat, at Lyons, in France.—Büttner exhibits in l. c. tab. xxi. p. 218, a bird's nest, containing four or five eggs, like quail-eggs, in a stone, four yards in circumference, discovered at Kindelbruck, and he mentions also in the same place, that in the same tufa bluish eggs, like ducks' eggs, have been discovered, which, when the shell was opened, the white and the yolk were quite distinctly to be seen, but *rather hard.* Near Vienna it is said a quarry exists where petrified birds, tongues and beaks of eagles, and other petrefacta are to be found.—Scheuchzer in his Querel. et Vindic. Piscium, represents in plate 11, a beam- or tail-feather from Oeningen. At Bottendorff, and on the Kuntzel lake, there are, according to Mylius, l. c. p. 13, slate-stones containing birds and beaks, to be found," etc. etc.

We give the original:—

"§ VI. Alle diese *fata* haben auch die Vögel, Insecta, Gewürme und Ungeziefer gehabt. Mylius, in s. Memor. Sax. Subterr. pl. i. relat. iv. p. 47, gedencket einer Henne, die vor wenigen Jahren in einer Berg-Nieren in dem Illmenauer Berg-Werck gefunden worden, welche Er tab. iv. *sub num.* i. p. 74, wie sie in dem Steine zu sehen im Kupffer vorgestellt. Baccius, de Thermis, lib. v. c. 4. *fol.* 282, erzehlet, dass Er eine versteinerte Henne mit Eyern gesehen, die man in den Salz-Gruben gefunden. T. Weichard Valvasor hat (davon Er in der Ehre des Herzogthums Crain, lib. iv. c. 2, p. 478, gedacht) bey Landes-Preis über dem Berge in einem Graben nebst vielen Meer-Muscheln und anderen versteinerten Stücken ein Vogel-Nest mit einem kleinen auf den Eyern sitzenden Vogel angetroffen, welches Er dem Mons. Henry Garbusat nach Lyon in Franckreich geschickt. Büttnerus, l. c. weiset in der XXI. Tab. *ad p.* 218, ein versteinertes Vogel-Nest, darinnen 4 oder 5, weisse Eyer gelegen, den Wachtel-Eyern gleich, in einem Gestein, das 4 Ellen starck gewesen, von Kindelbruck, und *pag. ead.* meldet Er, dass eben in diesem *Topho* man ehemals blaulichte Eyer den Enten-Eyern gleich gefunden, darinnen als man sie zerstupfet, die Schale, das Weisse und Dotter wohl zu unterscheiden gewesen, aber alles sehr verhärtet. Hinter Wien soll ein Steinbruck seyn, worinnen man petrificirte Vögel, auch Zungen und Schnäbel von Adlern und andern Vögeln im Gestein sieht. SCHEUCHZER in s. Querel. et Vindic. Piscium stellt in der 11. Tab. eines Vogels Schwing- oder Schwantz-Feder in einem Schiefer-Stein von Oeningen vor Augen. Zu Bottendorff und Küntzel-See brechen nach MYLII Bericht, l. c. p. 13, Schiefer-Steine mit Vögeln und Bienen," etc. etc.

Baier, 1722, says in his 'Fossilia Diluvii Universalis Monumenta,'* page 20:—

"§ XII. Of the winged kind there have been but very few fossil remains discovered as yet, but they are not therefore to be undervalued. JOH. DAN. MAJOR, in his Dissertat. Epist. de Cancris et Serp. Petrefact. § 47, p. 38, quotes amongst the animal remains of the mountains, and in the middle of solid marbles, *beaks of birds*, but he mentions no authority, neither does he give any figures; he is, however, himself a serious and a trustworthy writer. Cl. Scheuchzer, in his Quer. et Vindic. Piscium, tab. ii., shows a *tail of a bird or rowing-feather in a fossil stone at Oeningen, the only specimen of the remains of the winged genus known as yet*, except the gallinaceous bird quoted by *Agricola*, lib. x. foss. cap. xv., and truly, this author quotes many fowls in fossil-stone discovered in the forest of Hercynia, and he does not only proclaim highly the magnitude and the disposition of all the organic parts of the bird transferred to the stone, but also the very lineaments of minor form imprinted by the mineral juice. Such a hen discovered in the stone-quarries of Henneberg, in Saxony, is described by *Mylius* in his Saxon. Subterr. relat. vi. et x. p. 74, fig. 2. Be it as it may, for greater certitude the laborious Buttner, p. 218, describes thus the birds'-nests and eggs discovered in the tufa-quarries of Thuringia, and which deserve notice."

We append the original passage:—

"§ XII. *Ex volucrum* genere pauca oppido fossilia adhuc in conspectum venerunt, sed tamen minime contemnenda. JOH. DAN. MAJOR, in Dissert. Epistol. de Cancris et Serp. Petref. § 47, p. 38, inter partes animalium, quæ in intimis sæpe montium visceribus, imo mediis marmorum solidorum corporibus, repertæ sunt, connumerat *rostra avium*, sed nullo auctore aut exemplo speciali nominato. Gravis tamen ipse scriptor est et fide dignus. Cl. Scheuchzerus, in Quer. et. Vindic. Piscium, t. ii. exhibet *caudæ avis vel remigem pennam in lapide fissili Oningensi conspicuam, unicum quod hactenus sit cognitum ex volucrium regno superstes monumentum*, excepto *Gallo Gallinaceo*, cujus meminit *Agricola*, lib. x. foss. cap. xv. Verum hic *Gallos Gallinaceos* ponit, tanquam plures in lapide fissili Hercyniæ Sylvæ expressos, neque satis declarat, utrum vera magnitudine et partium organica dispositione avem referat lapis, an sola lineamenta minoris formæ, a succi mineralis ramulis utcunque efficta; cujusmodi gallinam in saxo fodinarum Hennebergicarum depictam exhibet *Mylii* Saxon. Subterr.

* Brit. Mus. 458. a. 14. "Q. D. B. V. Fossilia Diluvii Universalis Monumenta, præside JOHANNE GULIELMO BAIERO S. Theol. D. et P. P. eruditis excutienda sistet a.d. 19 Martii A. R. S. ciol. sec. xii. GEORG. CHRISTOPH. EICHLER, Norimbergensis. Altorfl. Noricorum, 1725."

relat. vi. et x. p. 74, fig. 2. Quicquid horum sit, majori certitudine diligentissimus BUTTNERUS, p. 218, avium nidos et ova in Thuringiæ lapicidina tofacea inventa his verbis notatu dignis allegat: *Ich bekomme nochmahlige Versicherung,*" etc.

MYTILUS SPATHULATUS, A NEW CRETACEOUS SPECIES.

BY H. SEELEY, F.G.S.

A flint cast of a Mytilus has been obtained from the gravel of Barnwell, near Cambridge, by Mr. Percevall, B.A., Trin. Hall, and entrusted to me for description.

Form elongated and narrow, attenuated anteriorly, with valves deep, and longitudinally striated. The anterior outline of the lips is straight, that of the posterior side a gentle curve, which is somewhat straightened towards the apex. The shell is about three times and a half as long as wide, and widest below the middle. The lateral outline of the valves is lanceolate, the greatest height being in the anterior third.

From the umbones the [subacute] line of inflation ascends, and curves posteriorly, so as to overhang the hinge. It then becomes rounded, and curves into the middle of the shell. The sides descend from it nearly straight. So, on the anterior side of the umbonal end, the sides slope somewhat away from the lips, penthouse-like; while on the posterior side they slope somewhat together, forming a shallow trough. The height of the shell is more than twice its transverse diameter.

The whole is marked with numerous, close, very fine, longitudinal striæ, which appear to be crossed by fine striæ, coincident with the lines of growth, but wider apart. The lips are dentated.

This remarkable form, the first Mytilus yet noticed from the English chalk, must have had a very thin shell, since the faintest exterior ornament seems all preserved on the flint cast.

It is constricted at intervals by rugose bands of growth.

The high valves, laterally compressed form, straight anterior side, and very compressed umbonal end, will readily distinguish this from every other striated cretaceous species. All the forms yet observed in the chalk are striated.

CORRESPONDENCE.

Spiral Planetary Orbits.

Dear Sir,—As a regular subscriber to the 'Geologist,' and one interested in its success, I doubt not you will pardon me for a few remarks upon your editorial articles in the last two numbers.

There are certain views put forward which, unless I am mistaken, are opposed to the known facts of physical astronomy, and although my mathematics are rather rusty, I think I am justified in the following criticisms. At p. 442 you speak of effects which changes in the sun's mass would produce in its attraction upon the earth. But would not any matter either dissipated from or deposited on the sun, continue to attract the earth equally before and after dissipation or deposition, the centre of attraction being in every case the centre of gravity of that matter the sun and the earth, and the whole quantity of matter continuing constant. Nor can it be supposed that the position of the centre of gravity could be sensibly altered by such changes.

At p. 443 you refer to Tyndall's expression that the moon "skids the earth." He is considering her tide-generating influence, and shows that she must retard the earth's *rotation*, but you have spoken, unintentionally no doubt, as if this action had an effect on the orbital motion. Now it is a well-known principle of mechanics, that the motions of rotation and translation are independent of each other; although they may have been originally both given by the same impulse.

Unless I am wrong, there is a mistaken idea which runs through portions of your articles in Nos. 72, 73. You appear to suggest that with a larger extent of orbit there would be greater velocity of the earth in her orbit, and that the effect of a diminished orbit through the action of a resisting medium would be to lessen the velocity in the orbit. One passage in which this idea is presented is this, "if we consider the effects of a higher orbital velocity, we shall find it would give rise probably to a larger extent of orbit."

Now it is usually considered (I may say proved) that the reverse is the case. This may be deduced from Kepler's third law, that the squares of the periodic times of the planets are proportional to the cubes of their mean distances,—a law which is proved, from mechanical considerations, to be true of *all* cases of planetary motion.

Suppose, for simplicity's sake, that the orbit may be considered a circle for one revolution, which, with the rarity of the cosmical ether and smallness of the ellipticity, is sufficiently true for the purpose.

Expressed symbolically, let T be the periodic time; a, mean distance:

$$\therefore T^2 \propto a^3$$

But in the case of a circular orbit, the velocity (V) is constant:

$$\therefore TV = 2\pi a$$

$$T = \frac{2\pi a}{V}$$

$$\therefore \left(\frac{2\pi a}{V}\right)^2 \propto a^3$$

$$\therefore V \propto \frac{1}{\sqrt{a}}$$

$\therefore$ As the distance of a planet from the sun is increased, the velocity in the orbit will be diminished, and *vice versâ*.

Hence, paradoxical as it might appear, the effect of a resisting medium by causing the planets to fall towards the sun, and so diminishing their mean distances, is to increase the orbital motion of the heavenly bodies (*vide* Pratt's 'Mechanical Philosophy,' p. 600). Any changes of the velocity of rotation would be wholly independent of these effects.

Believe me, my dear Sir, faithfully yours,

O. Fisher.

Elmstead, Colchester, 2nd January, 1864.

Mammalian and Cave Relics.

My dear Sir,—Although far enough from "Grays Thurrock," I could wish Dr. Falconer could look over my specimens of "mammalian fauna" collected in the caves here. Besides that cave on which a paper was read by me at Oxford, and where Dr. Falconer showed me the kind attention of an older student of geology, and another cave, of which an account was read in my name at the Cambridge meeting, I have this summer met with a third cave containing the usual remains, mixed with the same flint-chips, and opened another barrow in that locality in which these latter specimens occur.

By the way, I do not think a very curious notice of flint-chips which I discovered in my professional reading has yet appeared in print, except from my pen, and where it was not likely to come before students of science. Most are aware that in the 5th chapter of Joshua, verses 2 and 3, mention is made of "the knives of flint," with which he re-circumcised the children of Israel; but I do not think the following record is patent, because it occurs only in the Septuagint, which often *enlarges* on matters only briefly noticed in the Hebrew text. In Joshua xxiv. 30, it is written, "And they buried Joshua in the border of his inheritance, and *they placed with him in his tomb* (query a tumulus?) *the flint-knives with which he had circumcised the children of Israel; and there they are unto this day.*" The italics show the Septuagintal amplification of the Hebrew text.

It is impossible not to put "this and that together,"—I mean the chips in our tumuli and his,—and not to speculate upon the *possible* fact that religious rites had to do with the interments of these, and no other implements. I by no means would say I think it was so; but the fact is the parent of the thought. I wish Dr. Falconer could inspect my collection of bones. One "undecided point" I should like to discuss with him, namely, the comparative age of these mammalian bones, and of the great quantities of *other* bones usually found here nearer the surface, or on the surface of the red mould with which the caves are filled. Besides the bones of sheep, and swine, and horses, in what Buckland called the churchyard state, there are plenty of fish-bones, and some curious ones too, that puzzle most of my scientific friends, upon a personal inspection.*

Would it be too much to ask you to say where I can "beg, borrow, or get" the notice of the Torquay cave, so as to have an accurate account of the exact position, and state of the flint-chips found there? Some of us—myself for one—live in places so out of the world, that we are practically denied access to sources of trustworthy information near at hand to all metropolitan students.

I want the doctor's opinion, too, as to the date of the breaking up of the usual *older* stalagmitic crust, the thick remains of which adhere to the sides of these caves. I fancy my *fish*-bones were under this in one instance.

I am, Sir, ever yours faithfully,
GILBERT N. SMITH.

Gumfreston Rectory, Tenby, South Wales.
Dec. 19th, 1863.

* Are any frog-bones? In the Heathery Burn cave there were lots of frogs' bones, which were called fish-bones until the specimens were sent to me for inspection.—ED. GEOL.

Sandstone Hammer in a Diluvial Deposit at Macclesfield.

Dear Sir,—I send a stone-hammer for your inspection, which was found a short time ago near Siddington, about six miles to the west of this town, in a boggy piece of ground, about 2 yards below the surface, and upon the Red Marl. Its length is 7½ inches, breadth 3¾, thickness 2½, hole for the handle 1⅝; one end is rounded, the other vertically wedge-shaped; and it is of superior workmanship, having been probably made at the close of the stone-period. In the second volume of the 'Geologist' there are several engravings of sandstone-hammers, but none, I think, similar to the one I have sent you. If you think this of sufficient interest, perhaps you may be induced to give a drawing of it in your next number. In composition it appears to partake in character with some of the lower grits which crop out about two miles distant southward, with a north-westerly dip. All the different beds of grit below the true coal-measures are well developed in this locality, and their basement or Gosedale series are in general very fine-grained, hard, and compact, and produce excellent material for the roads. The Millstone Grit of this district possibly attains a depth of more than 3000 feet. One or two of the upper beds of grit contain thin seams of poor coal, which belong to the lower measures, and are only occasionally worked, not being remunerative; they are not very fossiliferous. It appears rather strange that the natives of this part of the country during the prehistoric or stone age should have resorted to the fabrication of sandstone-hammers, when if the question of durability were at issue, that qualification was always obtainable, since the whole of this neighbourhood was thickly strewed during the glacial period with almost every variety of the hardest igneous rocks, interspersed with hard sandstones and rounded limestones of various geological periods. The advancement of agriculture has now almost obliterated those deposits from the surface of the lower levels and plains, but on higher ground this is by no means the case. The moorlands and elevated districts are still dotted by boulders in every direction, and among some fields about four miles from here eastward, upon an isolated patch of ground some acres in extent and at an elevation of 1000 feet, a remarkable colony of those erratics is still extant. Blocks of quartz-rock, basalts, various granites, greenstones, porphyries, etc.,—more or less grooved, scratched, or smoothed,—lie scattered about in wild and chaotic profusion. There they remain in their primitive position, unaffected by time, untouched by the hand of man, and represent perhaps a true aspect of this part of the country immediately after its last upheaval above the waste of waters. At a mile and a half to the south of the scene just described there is an extensive outlier of the drift, which contains marine shells of arctic type, about 1200 feet above the sea-level. It is chiefly composed of coarse sand and gravel, and in one place has an escarpment of 30 feet. This rests upon a plateau or terrace of shale and grit, which denotes the ancient bed of a swift stream, that has now cut its way almost perpendicularly through the latter strata to a depth of 20 feet. About the middle of the section or escarpment there is a thick bed crowded with large water-worn pebbles and pieces of rough sandstone or grit; and this is also the shell-bed. These have probably been tranquilly deposited by stranded ice, after floating hundreds of miles from their Scandinavian home. The whole of Macclesfield is built upon the drift at an elevation of more than 500 feet. On the eastern side of the town there are two or three distinct terraces or former levels of the river many feet above its present bed, and the superficial sand and gravel overlying the boulder clay contain quantities of minute fragments of boreal shells.

The study of the glacial periods may be considered a most sublime and interesting subject, connected as it is so intimately with the history and antiquity of man. The cataclysms and many other physical phenomena which occurred in these latitudes are amazing; and perhaps it were a misfortune, for the sake of truth and the advancement of science, that the genus Homo existed during the above periods in a low and debased form of organization. For countless ages he trod the earth, in all climes, a wandering savage; and almost the only records left of him as works of art or design, which serve to distinguish him, in point of intelligence, from the brute creation, are a few specimens of rudely-chipped flint-instruments, that were used by him alike for offence, defence, hunting, and other purposes.

From later researches, if the conclusions of the antiquarian and geologist are to be accepted, it would appear that we must remove still further back in geological time the chronology of the human epoch. One species of a low form is mentioned as having become extinct, while it is affirmed that the genus was represented by species in the Pliocene and even the Miocene period. Towards the Eocene beds of Suffolk, this *vexata quæstio* seems to be trending; since in them, according to a certain theory, there is to be found a fossil that may be the earliest prototype of the Bimana. I am, dear Sir, yours respectfully,

J. D. Sainter.

Macclesfield, January 5, 1864.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

East Kent Natural History Society.—At an evening meeting, held at Canterbury, on November 24th, a lecture "On the Tertiary Beds of Kent" was delivered by W. Whitaker, B.A., F.G.S., of the Geological Survey of Great Britain, of which the following is an abstract:—

The sedimentary rocks are divided by geologists into three groups, Primary, Secondary, and Tertiary. The formations belonging to the first and oldest of these periods do not occur in the south-east of England, but are confined to the north and west. Of the Secondary period, only the higher formations (the Wealden and Cretaceous rocks) crop out to the surface in Kent. Of the Tertiary beds, on the contrary, only the lower divisions are known for certain to occur in this county, where, however, they are better developed and exposed than anywhere else.

Before treating of the Tertiary formations, it is needful to say a few words of the underlying Chalk, the highest of our Secondary rocks. It is a sea-deposit, rich in fossils, of which many are such as must have lived at a great depth and apparently in the sea of a warm climate. From the fact that the fossils of the overlying beds are altogether of different kinds from those of the Chalk, it has been inferred that those beds were not at once deposited on the Chalk, but that after the deposition of the latter, a long time passed away before other beds were formed over it.

The Kentish Tertiaries belong to the "Eocene," or Lower Tertiary series; and consist, in ascending order, of the Thanet beds, the Woolwich beds, and the basement bed of the London Clay,—grouped together by Prestwich (to whom we owe nearly all our knowledge of these beds) under the name of "Lower London Tertiaries,"—the London Clay and the Lower Bagshot Sand.

1. *The Thanet Beds.*—This formation, almost a purely Kentish one, being but little shown in any other county, thins out a little west of London.

Under London it is from 30 to 40 feet thick, and consists of fine, soft, light-coloured sand, without fossils. It continues the same through West Kent, but with a thickness increasing to 60 feet or more. In East Kent a gradual change sets in, the beds get more clayey, and fossils occur in parts; until the Isle of Thanet, and to the south, there are little else than marls, mostly hard, and clays—with a little sand at top however—often full of fossils, and from 80 to 100 feet thick. At the bottom, *everywhere* there is a bed of clayey greensand, with green-coated flints lying at once on the Chalk.

The number of kinds of fossils in these Thanet beds is small. They are all marine, and seem to be such as would have lived in the sea of a more or less temperate climate; the chief genera are Cyprina, Cytherea, Pholadomya, Cucullæa, Thracia, Nucula, Corbula, Sanguinolaria, all bivalve shells, and Ampullaria. The cliffs and the shore, west of the Reculvers, yield those of the uppermost and more sandy part of the formation; whilst at Pegwell Bay the lower marly part is also shown. At both places there are fossil-bearing sandstones in the upper part. The Bekesbourne cutting of the London, Chatham, and Dover Railway yielded many fossils to Mr. Dowker, one of the members of the Society, who has described this section in a former volume of the 'Geologist.'

Where a section shows a good thickness of the Thanet beds above the Chalk, the junction of the two formations is even; where, however, there is but little of the former, the junction is generally more or less wavy, and there are often large funnel-shaped hollows, known as "pipes." These have been slowly formed by the action of water containing carbonic acid in solution, which has dissolved away the Chalk (carbonate of lime) in an irregular and unequal manner, and the beds above have fallen down into the hollows thus left. It is where the Chalk is but thinly covered, and therefore where water would the more easily filter through to it, that one would expect this action to occur to the greatest extent, and such is the case.

2. *The Woolwich Beds* are remarkable for their ever-changing structure, especially in Kent, in which county, however, there is none of the brightly-coloured mottled plastic clay, that occurs so generally in this formation in the western part of the London basin.

In the "far west" of Kent, near London, the Woolwich beds are about 50 or 60 feet thick, and consist of alternations of sands, beds of pebbles, and clays with shells; and at the bottom, a bed of greenish sand with pebbles, sometimes resting somewhat unevenly on the underlying Thanet Sand.

The shell-beds must have been deposited in a river or estuary, for some of the shells are of a kind that could not have lived in the sea,—such as the bivalve genera Unio, Cyrena, and the univalve Paludina, Neritina, Melania, and Melanopsis. There are also oysters, and other genera that show that the beds are not altogether freshwater, but partly of brackish-water origin. As is usually the case with freshwater beds, fossils are most abundant in numbers, but not in kind,—few species, but hosts of individuals. Mr. Prestwich infers that the river which deposited these shells, and the clay that contains them, flowed down from an island, which he supposed to have occupied at that time part of our present Wealden district. The climate indicated by the shells is that of a temperate region, and the remains of plants that are found here and there, point the same way. These shell-beds are well shown in the large ballast-pit, at Charlton, near Woolwich, at Counter Hill (New Cross), Loam Pit Hill (Lewisham), and very many other places.

The great shingle-beds of the neighbourhood of Bromley and Blackheath, have been in part classed by Mr. Prestwich, though doubtfully, with the "basement-bed" of the London Clay; but there is some reason to think that they may all belong rather to the Woolwich beds. In some places, and markedly in the "rock-pit" in Sunderidge Park, near Bromley, and in the railway-cutting at Beckenham, there are fossils in the pebble-beds; and it seems strange that many very delicate shells should be preserved in a loose mass of hard pebbles.

In some places, as on the hill above Abbey Wood, the shell-beds have thinned out, and there is nothing but sand and pebbles from the top to the bottom of the formation. The pebble-beds, as might be expected of deposits of that nature, are merely lenticular masses on a large scale, of great thickness at one spot and near by altogether absent.

Eastward of the valley of the Cray, Tertiary formations have suffered much from denudation, and from Dartford to beyond Gravesend are present only in the form of outliers. The clay shell-beds get thinner, and at the great section on the bank of the Medway, at Upnor, are only 6 feet thick, the sand above, however, also containing shells, but not that below.

For some way east of Rochester this formation has been almost wholly denuded, but it comes on again west of Sittingbourne. Near this latter place the estuarine shell-beds thin out and are not seen further eastward. The pebble-bed at the bottom is also lost, and it is then difficult to draw the line between the Woolwich beds and the underlying Thanet Sand, the former, however, being mostly a coarser and sharper sand, with here and there a few pebbles. The fossils also of the two formations are more alike, those of the Woolwich beds being here of a purely marine kind, and in great part of the same species as those of the lower formation, but of rarer occurrence. The sands that in East Kent represent the Woolwich beds are 25 to 40 feet thick, and are well shown on the coast west of the Reculvers, in sections near Canterbury and Ash, and in the railway-cutting at Richborough Castle.

3. *The Basement Bed of London Clay* consists, near Lewisham and Bromley, of a more or less clayey pebble-bed, from 3 inches to 2 or 3 feet thick, and is well shown in the large pits at Loam Pit Hill, near the former place.

Mr. Prestwich classes with this bed, though somewhat doubtfully, the thick wide-spread mass of shingle of Blackheath, Charlton, etc.; but in the railway-cutting, east of Bickley, a sandy pebble-bed, like that of Blackheath, is seen to be overlaid by the usual clayey pebble-bed at the bottom of the London Clay, and it would seem therefore that the thick mass of pebbles in sand at Blackheath, etc., do not belong to this bed; whether they belong to the underlying Woolwich beds or not, is another question.

From this western part of Kent there are no sections of the "basement-bed" for some distance eastward, and possibly it may have thinned out. At Upnor, near Rochester, however, the whole of the Tertiary beds, from the lower part of the London Clay to the top of the Chalk, are shown. The former is underlaid by some 4 or 5 feet of fine light-coloured sands with shells, in a very friable state, and with pebbles near the bottom. These Mr. Prestwich classes with the "basement-bed," and they certainly seem to be separable from the underlying sands and shell-beds of the Woolwich series, though, on the other hand, they are sharply divided structurally from the stiff London Clay above The fossils in them are, for the most part, of species generally found in the basement-bed (chiefly of the genera Cytherea, Cyprina, Cardium, Pectunculus, Natica, and Lamna teeth); but there are also a few of the estuarine shells of the Woolwich beds, and in abundance Cyrena, Cerithium, and Melania.

This bed (or rather the set of sands, etc., that are usually classed with it) does not occur for some distance to the east, owing to the extent of the denudation of the Tertiaries; coming on again, however, near Sittingbourne with the same general characters and a little thicker. It has been observed in the cutting north of that town, on the Sheerness branch-line. Near Boughton and Canterbury this sand is again shown, and it contains flint-pebbles and ironstone. At the mouth of the tunnel, on the Whitstable Railway, near the second place it may be well seen, and the thick pebble-bed at the base, cemented into a hard mass by the ironstone, is remarkable. At Shottenden Hill there is a great thickness of the flint-pebbles.

The fine cliff-section between the Reculvers and Herne Bay shows this sand-bed very clearly. It has here an average thickness of 20 feet; is crowded with fossils; contains large blocks of hard tabular sandstone, often almost made up of fossils or casts of fossils, and smaller blocks of fossil-bearing iron-sandstone; and has a well-marked pebble-bed, from a few inches to more than a foot thick at the bottom. The fineness and looseness of the sand of this division of the Tertiary series is here well shown: on windy days many tons' weight of this sand are blown away from the face of the cliff, the wind indeed being very powerful in wearing away these cliffs. The fossils are of a London Clay type; but many of them occur also in the beds below. Sharks' teeth and vertebræ are plentiful, and amongst the shells the bivalve genera Cyprina, Cytherea, and Cardium, and the univalves Natica and Aporhais.

In all these East Kent sections, it is to be noted that the London Clay is sharply divided from, and nowhere passes into the sands below, and that it nearly always has a few pebbles, green grains, and sharks' teeth at the bottom, which is rather sandy, and not unlike the undoubted basement-bed in the western part of the London basin, and this may perhaps be the real basement-bed. The underlying sands are more like the beds below them in mineral structure; but more allied to the London Clay by fossils.

4. *The London Clay* is not only of much greater thickness, but also of more uniform mineral character than the lower formations. It consists almost throughout its whole thickness of stiff dark-bluish-grey clay, weathering brown, with now and then a bed of nodular masses of clayey limestone (known as "septaria," from having septa or divisions of carbonate of lime), from which Roman cement is made. The lower part is generally roughly laminated, and abounds in transparent crystals of selenite (sulphate of lime). The upper part, which however rarely occurs, having been for the most part denuded, is also somewhat laminated and sandy, and generally passes up into the overlying Bagshot Sand (present only in the Isle of Sheppey).

The full thickness of the London Clay in the most western part of Kent is calculated to have been about 450 feet; so great a thickness occurs nowhere in West Kent, however, the highest beds of the formation having been denuded. Shooter's Hill, indeed, is the only place where the greater part of the London Clay has been left. In the Isle of Sheppey the thickness is calculated at 480 feet, the greatest known. As might be expected from its greater thickness, the London Clay occurs at the surface over a wider belt of country than the thinner underlying formations.

The fossils, in some places abundant, but often "conspicuous by their absence," show that the clay is a sea-deposit. Moreover, as the many species occur for the most part from top to bottom of the formation, and as the mineral character is the same throughout, it follows that there must have been a slow subsidence going on, to make up for the shallowing of the sea by the continuous deposition of sediment, and thus to allow the life of the age to keep the same during the whole time of deposition of these hundreds of feet of clay, which it could not do if the depth of the sea were so much lessened as would be the case without subsidence.

The only place where any number of fossils have been found in the London Clay in Kent, is the Isle of Sheppey, where, however, the cliffs have yielded a rich harvest both of species and specimens. These, which are from the higher part of the formation, give evidence of the existence in those long-past ages of corals, star-fishes, sea-urchins, an abundance of Crustacea (crabs, lobsters), often forming the nucleus of septaria, mollusks in great plenty, fish (especially sharks, the teeth of which are very common), and rays and reptiles (turtles, tortoises, crocodile, and serpent.) The remains of a small pachydermatous mammal have been found near Herne Bay. The most remarkable of the Sheppey fossils, and which are far less common elsewhere, are the plant-remains. These are chiefly of the leguminous and coniferous orders and palms, and consist of fruits, seeds, and stems. They are in iron-pyrites (sulphide of iron), and therefore very difficult to keep, as that substance often decomposes when exposed. They show that the neighbouring land on which they grew must have been much warmer than our present temperate climate; and this evidence is strengthened by that of the remains of the Mollusca, amongst which the univalve Nautili, Cones, Cowries, and Volutes show that the sea in which they lived must have been in a warm climate. Shells of many other genera occur, such as Fusus, Natica, Pleurotoma, Rostellaria, and the bivalves Cardium, Pectunculus, and Teredo, a great deal of the wood having been bored by the last. These shells, like the vegetable remains, are in the state of casts in iron-pyrites.

The middle and lower beds of the London Clay, near Whitstable and Herne Bay, have yielded fewer fossils.

A noteworthy feature of the London Clay cliffs is the frequent occurrence of landslips; nearly the whole face of the sloping cliff being generally made up of the fallen masses. In dry summer-time the clay is shrunk by the heat, and deep cracks are formed; when rain falls, much water finds its way down these cracks, loosens the clay, and makes it slippery, so that masses can more readily fall down. The destructive action of the weather is, however, greatest in the winter, when the water in the deep cracks freezes, and the vast force put forth in its expansion, on becoming ice, loosens the beds, which would then tend to slip down after a thaw. Early in the present year (1863) a slip occurred which threw a long strip of land, about two acres in extent, some way down the cliff: the young wheat was growing very well in its strange position.

5. *The Lower Bagshot Sand* occurs in the form of a thin outlier on the highest part of the Isle of Sheppey; the only place in Kent where the London Clay is capped by this formation, which has been worn off altogether in other parts of the county. The sand is light-coloured, more clayey towards the bottom, and generally passes into the sandy clay forming the uppermost part of the London Clay. It may be seen for more than a mile along the cliff near Minster, and is at the most some 30 feet thick.

Although of so small extent and thickness, this outlying mass of sand is of much geological value. Firstly, it proves that the Bagshot series once spread over these parts, as the outliers at Rayleigh and elsewhere on the opposite side of the Thames prove its former extension over Essex; and, secondly, it enables us to calculate the thickness of the London Clay from top to bottom, which clearly could not be done without that formation being capped somewhere by a mass of the next overlying one, to show the real top; its bottom being shown by the outcrop of, or by wells being sunk through to, the formation next below.

6. *Crag* (of Prestwich).—Near the edge of the Chalk escarpment near Folkestone, and to a smaller extent in other like places, there is found a deposit of sand, often ferruginous, the age of which is not yet made out with certainty. It seems not to be connected with any of the older Tertiary beds, and it is not like any of the Drift-beds of the district. From the occurrence of a peculiar set of fossils in a pipe of this sand in the Chalk above Lenham, Mr. Prestwich was led to class it with the "Crag," an Upper Tertiary formation of much later date than any we have been considering. The fossils, however, being only in the state of casts in ironstone, and merely from a small pipe, the evidence is hardly conclusive, and the classification must be looked on as provisional. There is therefore a very doubtful point in the Tertiary Geology of their county for the "East Kent Naturalists" to work out.

Geological Society.—*December* 2, 1863.—1. "On the Correlation of the Oligocene Deposits of Belgium, Northern Germany, and the South of England." By Herr Adolf von Koenen. Communicated by F. E. Edwards, Esq., F.G.S. Railway-cuttings in the New Forest (Brockenhurst, etc.) have recently exposed certain marine beds overlying the Lower Headon (freshwater) series, and containing fossils hitherto unknown in England, but which, as Herr von Koenen showed, constitute the marine equivalent of the Middle Headon strata.

The author gave an exposition of the current opinions upon the correlation of those English and foreign "Upper Eocene" or "Lower Miocene" strata, to which Professor Beyrich has given the name "Oligocene," and briefly sketched their distribution and limits upon the Continent. He then gave a list of fifty-nine New-Forest (Middle Headon) fossils, which he had determined, and stated that, of this number, forty-six occur in the Lower Oligocene of Germany, and twenty-three are characteristic of that formation; twenty-one of these species occur in the Barton Clay, four in the Middle Oligocene, and eight are peculiar to the Brockenhurst beds. He therefore concluded that the Headon and Brockenhurst strata are on the same horizon as the Lower Oligocene; and he confirmed the opinion of previous observers, that the Hempstead beds are the equivalent of the "Grès de Fontainebleau" and of the Middle Oligocene of Germany.

2. "On the Liassic Strata of the Neighbourhood of Belfast." By Ralph Tate, Esq., F.G.S.

In the neighbourhood of Belfast the following members of the Lias formation were stated to occur, namely:—The zone of *Ammonites Bucklandi*, the White Lias, and the zone of *Avicula contorta*.

The characters of these subdivisions in the district under consideration were described in detail by Mr. Tate, who gave sections of the beds exposed in Colin Glen and at Cave Hill, at which localities the three zones are seen; he also gave sections of the *Avicula contorta* beds as exposed at Woodbarn and at Whitehead, and lists of the fossils found in the strata of each subdivision at the localities mentioned, noticing that, in the zone of *Ammonites Bucklandi*, that Ammonite is replaced by *A. intermedius*, the other fossils being of the same species as occur in that zone in England; and he concluded with some general remarks on the distribution of the members of the Lias in the North of Ireland.

3. "Notes on the Devonian Rocks of the Bosphorus." By W. R.

Swan, Esq. In a letter to Sir R. I. Murchison, K.C.B., F.R.S., F.G.S., etc.

The lithological and stratigraphical characters of the rocks of the Bosphorus having been noticed, the author gave a general description of the fossils occurring in them,—namely, *Spirifer* (broad-winged and small species), *Orthis*, and other Brachiopods; *Homalonotus* and other Trilobites; together with Corals of the genus *Favosites* associated with the well-known *Pleurodictyum problematicum*. Graptolites were stated to be entirely wanting, and Cephalopods to be very rare. Mr. Swan therefore inferred that these strata were of the age of the Lower Devonian rocks of the Rhine.

December 16, 1863.—1. "On the Pebble-bed of Budleigh Salterton." By W. Vicary, F.G.S. With notes on the Fossils by J. W. Salter, F.G.S.—The south coast of Devonshire, from Petit Tor, near Babbacombe Bay, to a little beyond Sidmouth, exhibits cliffs of New Red Sandstone; one of the beds of which, near Budleigh Salterton, is composed of pebbles of all sizes and of a flattened oval form: this bed attains a maximum thickness of about 100 feet, and some of the pebbles composing it were found by Mr. Vicary to contain peculiar fossils.

Mr. Vicary gave a description of the physical features of the area over which the pebble-bed extends, and entered into the stratigraphical details of this and the associated strata, referring to Mr. Salter's note for information upon the affinities of the fossils. In his note, Mr. Salter observed that, on comparing the fossils of the Budleigh Salterton pebbles with those from the Caen sandstone in the Society's Museum, he found that all the species contained in the latter collection were also represented in the former. The general aspect of the fossils was stated to be quite unlike that exhibited by English Lower Silurian collections, and Mr. Salter therefore suggested that the exact equivalent of the Caen sandstone does not exist in England. This difference in the two faunas appeared to him to favour the theory of the former existence of a barrier between the middle and northern European regions during the Silurian period.

2. "Experimental Researches on the Granites of Ireland.—Part IV. On the Granites and Syenites of Donegal, with some remarks on those of Scotland and Sweden." By the Rev. Samuel Haughton, F.R.S.—The author discussed in detail the mineralogical composition of each of the fifteen Donegal granites, and described the method usually employed by him in solving lithologico-chemical problems, coming to the conclusion that nearly half of these granites are not composed altogether of the four minerals (quartz, orthoclase, oligoclase, and black mica) which are found in them in distinct crystals, and that the remaining varieties, even if they be composed of these minerals, must have a paste composed of the same minerals, but with a slightly different composition. Professor Haughton then discussed the composition of the syenites of Donegal, and instituted a comparison between the granites of that district and those of Scotland and Sweden, remarking that those of the last-named region have the same stratified structure as the granites of Donegal.

3. "On the recent Earthquake at Manilla." By J. W. Farren, Esq. Communicated by the Foreign Office.—In two letters to Earl Russell, the author described the damage done by this earthquake, observing that 289 persons were killed, and a large number more or less injured.

4. "Extracts from Letters relating to the Further Discovery of Fossil Teeth and Bones of Reptiles in Central India." By the late Rev. S. Hislop. Communicated by Professor T. Rupert Jones, F.G.S.—The remains alluded to consist of (1) a series of reptilian bones, some bearing

teeth, mostly Labyrinthodont, and some probably Dicynodont, from the (Triassic?) red clay of Maledi, in which teeth of Ceratodus occur; and (2) several teeth similar to one from the Eocene clays of Takli, near Nagpore, and another like a conical tooth from the Eocene beds (with *Physa Prinsepii*) of Physura, from the same neighbourhood as that in which the set No. 1 was found. At Phísdura (Tertiary) large reptilian bones (including a femur 1 foot across at the condyles, and a vertebral centrum seven inches across) have been found associated with large coprolites, *Physa Prinsepii*, and *Paludina Deccanensis*. Mr. Hislop stated his belief that the Mangali beds, the Kordihad shales, and the red-clay of Maledi, should be placed above the plant-bearing beds of Nagpore, instead of below them, as heretofore supposed.

January 6, 1864.—1. "On the recent Geological Changes in Somerset, and their date relatively to the Existence of Man, and of certain of the Extinct Mammalia." By G. S. Poole, Esq.

In describing the general physical features of the district treated of, which lies between Clevedon and Taunton, the author noticed especially the embankments which protect the land from periodical inundations, stating his belief that they were constructed by the Romans; he also described the "turbaries" or peat-moors, endeavouring to explain their mode of formation, and noticing their relation to the alluvium and the sand-banks of the district. Mr. Poole then endeavoured to prove that the area under consideration had been subject to considerable changes of level in comparatively recent geological times, and that man existed in the district prior, and some of the extinct mammalia subsequently, to the last of such changes,—asserting, in support of the last conclusion, that the remains of *Elephas primigenius*, *Rhinoceros tichorinus*, etc., had been found in a stratum above that containing the bones of man and pieces of pottery; and he concluded by examining the evidence of the extent and date of the last subsidence.

2. "On the Structure of the Red Crag in Suffolk and Essex." By Searles V. Wood, jun., Esq. Communicated by Searles V. Wood, Esq., F.G.S.

By reference to a tabulated description of about fifty sections taken from various parts of the Red Crag area, the author showed that the deposit is structurally divisible into five stages, of which the 1st, 2nd, 3rd, and 4th (counting upwards) were not deposited under water; but from their being regularly laminated, at angles varying between 25° and 35°, and possessing (with the exception of the 2nd) an unvarying direction in every stage, he regards them as the result of a process of "beaching up," by which was formed a reef extending from the river Alde on the north, to the southern extremity of the deposit in Essex. Of these four stages, the 4th is the most constant and important, the 1st, 2nd, and 3rd being frequently either concealed by, or destroyed during the formation of the succeding stages. At Walton-on-Naze alone do any of the four lower stages contain evidence of being a subaqueous deposit; there the 1st stage is so, but it is covered by two reef stages, and these again by the 5th stage.

The 5th stage is invariably horizontal, and contains evidence of having been formed under water. This stage is developed in such a way as to show that it was formed in channels eroded in the older reef, and it is at its base that the coprolite workings occur. This stage also passes up at Chillesford into the sands and gravels, termed by the author the Lower Drift, which underlie the boulder clay; at other places a line of erosion exists between the 5th stage and the drift-sands.

Jan. 20.—1. "Observations on supposed Glacial Drift in the Labrador Peninsula, Western Canada, and on the South Branch of the Saskatchewan." By Professor H. Y. Hind, Toronto.

During an exploration of a part of the interior of the Labrador peninsula, in 1861, the author had an opportunity of observing the magnitude, distribution, and extraordinary number of the boulders on the flanks of the table-land of that area; and he commenced this paper with a detailed account of the results of his observations, referring also to the forced arrangement of blocks of limestone, shale, and Laurentian rocks in Boulder-clay at Toronto, and on the south branch of the Saskatchewan.

Professor Hind then described briefly the Driftless Area, in Wisconsin, discovered by Prof. J. D. Whitney, and the conclusions to which that geologist has been led by the study of this district. He next adverted to the beaches and terraces about the great Lakes, and considered their origin to be similar to that suggested by Mr. Jamieson for the Parallel Roads of Glen Roy. The formation of anchor-ice in the Gulf of St. Lawrence and at the heads of rapids in the great river itself was alluded to as one of the means by which river-beds may be excavated. The parallelism of escarpments in America, at great distances apart, and at elevations varying from 600 feet to 3000 feet above the sea, was next described, and their symmetrical arrangement suggested to be the result of glacial rivers undermining the soft strata of sedimentary rocks in advance of the glacial mass itself. These escarpments were also thought to represent different and closely-succeeding glacial epochs.

2. "Notes on the Drift-deposits of the Valley of the Severn, in the neighbourhood of Coalbrookdale and Bridgenorth." By George Maw, F.S.A., F.L.S.

The patches of Drift occurring in the Valley of the Severn from about four miles below Bridgenorth up to Shrewsbury, including a north and south range of about twenty miles, have been carefully examined by the author, and were described in detail in this paper.

Commencing with Strethill, a hill close to the entrance of Coalbrookdale, the author described the several beds which make up the Drift-deposits of which it is composed, and gave a list of the rocks which he had found in them. In the same manner he described in succession the neighbouring districts in which the Drift-deposits are exhibited, and gave a list of the fossils which had been found in the beds at the different localities.

In conclusion Mr. Maw put forward some hypotheses as to the period when the degradation of the older formations (the materials of which compose the Drift) took place, the manner in which the Drift was deposited, the extent of the submergence of England and Wales during the period of its deposition, and the influence of glaciers and glacier-action in its production.

Royal School of Mines.—Twelve Lectures on Chemical Geology, by Dr. Percy, F.R.S. — *December 10th*, 1863. — Geology has for its object the study of the nature and mode of formation of the exterior of the earth, which alone is accessible for investigation. That exterior is usually designated the "crust" of the earth, an expression which implies necessarily that the interior is not solid, but is in a state of greater or less liquidity. The received hypothesis is, that our planet was once molten, and that in the lapse of ages it has gradually cooled down, and has become solid on its surface. The lecturer did not propose to examine the foundations of this hypothesis; but used the word "crust" simply because it is a term perfectly well understood, and generally accepted, and not as any exponent of the lecturer's belief.

We are acquainted altogether with about sixty elementary bodies; and it is really remarkable how few constitute the great bulk of the earth's crust

—not more than five. These are—silicon, aluminium, calcium, oxygen, and carbon. The states of combination in which they occur are—silica, that is, silicon combined with oxygen; alumina, or aluminium with oxygen; and lime, or calcium with oxygen; and this lime is, for the most part, or, at all events, to a very large extent, in combination with carbonic acid, constituting marble and limestone in its various forms. Perhaps next in abundance we may rank magnesium; then, perhaps, would come hydrogen, iron, sodium, potassium, manganese, chlorine, sulphur, and phosphorus. The hydrogen is that existing in combination with oxygen in the form of water, and present in a state of solid combination in all clay. It is not there, as chemists term it, as hygroscopic water, water simply of moisture, which can be expelled at a low temperature, but it is there in a state of actual solid combination, and may therefore be considered as one of the constituents.

The geologist everywhere meets with problems of the highest interest which chemistry alone can solve; yet it is somewhat surprising that in this country the application of chemistry to the solution of geological phenomena should hitherto have received so small a share of attention. Not a few persons have attained the reputation of geologists who have either been ignorant of the great foundations of the philosophy of geology, or have had a very slight knowledge of the subject. To know and to remember the order of superposition of rocks, and to be able to recognize the fossils which they respectively contain, does not entitle a man to rank as a philosophical geologist. As well might a taxidermist lay claim to the title of zoologist, or an ornithologist to the title of botanist. The conquests which remain to be achieved in geology will, doubtless, result from the special study and application of the various sciences, and there is assuredly no line of investigation which promises richer fruit than chemistry.

The subject of this first lecture is silicon, perhaps the most abundant, or, certainly, one of the most abundant elements in the solid crust of the earth. This silicon has only recently been investigated in anything like a satisfactory manner. It exists in, and is the foundation of silica in its various forms. Silica exists in the well-known form of quartz, and consists of silicon combined with oxygen. In sand and in all clay, and in igneous rocks of various kinds, it is an essential constituent. In fact, it is everywhere. This silicon, when once united with oxygen, requires an extraordinary amount of affinity, or the exercise of an extraordinary force to *detach* it therefrom. It exists in three distinct states, the amorphous or formless state, in the graphitic state, and in the state of crystallized octahedral silicon.

In its three states, silicon differs considerably. In the amorphous state it occurs in the form of a chocolate-brown powder. In the graphitoidal state it is exactly like graphite, or very similar, occurring frequently in small hexagonal plates, as produced in the process for making aluminium. Then we have the octahedral form, the same form and the same crystalline system as that to which the diamond belongs. But here it is a most beautiful substance, of a metallic lustre, and a dark bluish-grey colour, considerably more blue than ordinary graphite, and more metallic in lustre. Silica consists, in round numbers, of about 48 parts of silicon and 52 of oxygen. The atomic formula adopted, and first suggested by Berzelius, is $Si\,O_3$, representing one equivalent of silicon combined with three of oxygen; but there are reasons for supposing that the more accurate expression is $Si\,O_2$, one equivalent of silicon combined with two of oxygen. Long ago it was ascertained by Schafgotsch that silica exists in two very different states. In one state crystallized as quartz, having a specific gravity of

2·6. All quartz, for example, has this specific gravity, and not only quartz, but chalcedony, hornstone, and flint, and yet these present no outward sign of crystalline structure. It is, however, maintained by Rose, and with some plausibility, that they consist of an aggregation of excessively minute crystals. He designates these forms of quartz as *crystalline*, in contradistinction to the ordinary form of rock crystal, which is distinctly *crystallized*. We have, then, crystalline quartz, and this apparently non-crystallized form of quartz just mentioned, chalcedony and the like, of the high specific gravity 2·6.

There is another form of silica in which the specific gravity never exceeds 2·3. It ranges from 2·2 to 2·3, and is never higher than that. This is what is termed amorphous, apparently non-crystalline silica; and these facts have, or may have, a very important bearing on certain geological considerations. All the crystallized silica of the high specific gravity polarizes light. The amorphous silica of low specific gravity does not polarize light. The distinctly crystallized silica which we have in quartz, when pulverized, reduced to extremely fine powder by trituration and levigation, does not differ chemically in any sensible respect from the powder of the apparently amorphous form of silica, flint, chalcedony, and the like. Both resist the action of boiling alkaline solutions, whereas the amorphous silica is copiously and readily dissolved by such solutions. The crystallized silica is produced in the wet way, and, so far as we know, only in the wet way. By the wet way is meant through the agency of liquids, never by fusion at a high temperature. The late M. Senarmont, who devoted considerable attention to the artificial formation of minerals, made microscopic crystals of quartz by dissolving silica in the nascent state in very dilute hydrochloric acid, and then exposing that solution in a closed tube to a temperature of between 200 and 300 centigrade; exactly similar, in all essential respects, to the rock-crystal of nature. It is true that the crystals were very small; but that in no way affects the truth of the conclusion. Sorby obtained crystalline silica by passing chloride of silicon into a tube along with the vapour of water, but he afterwards procured still more distinct crystals by decomposing glass at a high temperature by the agency of water. We may take an ordinary piece of glass and boil water in it for almost any length of time, without appreciably acting upon it; but if we expose ordinary glass to the action of water at a high temperature in a close vessel, the result is different, and the glass is rapidly attacked and corroded. By acting upon glass consisting of silica, lime, and potash, by water, at a high temperature, he obtained the well-known mineral Wollastonite, which is a silicate of lime; and he obtained perfectly transparent crystals of quartz, not less than two millimetres in length,—a distinct experimental proof of the formation of characteristic crystals of quartz, similar to those occurring in nature, by the agency of water. It is a fact that the heavy compact and the crystallized silica often occur together, and hence we may infer the similarity of the conditions of their formation.

To avoid confusion about crystalline and amorphous silica, it must be borne in mind that there is quartz which is distinctly, manifestly crystallized with the specific gravity of 2·6. Then we have silica of the same specific gravity, yet not appearing crystalline to the eye, although there are certain reasons for supposing that it may be composed of an aggregation of excessively minute crystals. Then there is the other distinctly amorphous non-crystalline variety, which has the low specific gravity of 2·3. Thus there are two apparently amorphous varieties of silica,—chalcedony, for example, and opal. If we compare common quartz with opal, both appear non-crystalline, and both, therefore, might be confounded under the term "amorphous;" but the term "amorphous" is restricted to this particular form of solid silica having the low specific gravity.

All attempts to crystallize silica by fusion have hitherto failed. Many experiments were made upon this subject a long time ago by means of the oxy-hydrogen blowpipe. Silica has been distinctly fused into small globules; there is no great difficulty about that. More recently, Deville, who has paid special attention to the application of high temperatures to metallurgical purposes, has succeeded in fusing silica in considerable quantities, and he has subjected it to slow cooling, but never in a single instance has there been the slightest trace of crystallization; and such silica—silica fused at these high temperatures—has always the low specific gravity of 2·3. The bearing of this will be seen by-and-by upon the supposed formation of granite and certain other igneous rocks. If we take a piece of crystallized quartz of a high specific gravity, and fuse it, we convert it into a substance somewhat resembling the silica of the low specific gravity, having the gravity of 2·3. Now that is apparently a small fact, but in a geological point of view it is one of the highest interest. Formerly, it was a marvel to melt a bit of platinum as big as a pin's head; now, Deville has succeeded in melting it in mass. This platinum sometimes contains silicon, and in fusion the silicon becomes oxidized, and converted into silica,—the melted silica swimming on the top of the melted platinum in the form of a thin, transparent, colourless liquid.

Gustave Rose found, that when perfectly transparent, entire rock-crystal underwent long exposure, say for eighteen hours, to a porcelain furnace, in which the temperature is exceedingly high,—being estimated at about 2000° centigrade—there was no alteration in the specific gravity at this temperature; but when the same crystal was exposed to the same conditions of temperature, having been previously pulverized—reduced to fine powder—its specific gravity was reduced from 2·6 to 2·3. Again, he found in the case of common flint having a specific gravity of 2·591, owing to certain impurities which interposed, that by exposure to this high temperature for a long time, its specific gravity was reduced to 2·237; another example of the influence of high temperature in reducing the specific gravity of silica in this particular state of aggregation.

We have now to consider more particularly this amorphous silica, or that form of silica to which Professor Graham has so well given the name of "colloidal, or jelly-like silica." This silica is obtained in various ways; one is by the decomposition of silicates by acids. Silicate of potash or silicate of soda will dissolve readily in water, the solution being known as water-glass; if we add, under certain conditions, an acid to that water-glass, the silica will immediately separate in the form of jelly. Under other conditions of dilution there would be no immediate separation of jelly whatever, but the whole of the silica will be retained in solution, though it be separated from its combination with the base by the addition of a stronger acid; but, on keeping, it will ultimately gelatinize, or during evaporation, by the application of heat, the silica will be thrown down in the jelly-like state. When evaporated to dryness, this jelly forms a white, amorphous powder. This gelatinized silica, or colloidal state of silica, is produced by the action of water on a peculiar compound termed "fluoride of silicon,"—a gaseous compound, consisting of silicon in combination with the element fluorine, which is an essential constituent of common fluor spar. It is a perfectly transparent, colourless gas, which immediately suffers decomposition by contact with water; hence, when this gas is allowed to escape into the atmosphere, under ordinary circumstances it produces a copious white smoke, due to the formation and deposition of silica. If fluor spar and sand be mixed with sulphuric acid, fluoride of silicon is formed, which, in passing through water, becomes immediately decomposed, depositing gelatinized silica. If we plunge the delivery-tube, conveying the gas, into water, the quantity of silica immediately produced would be so great as to stop up the tube, and to burst the flask. In order to avoid that effect, it is usual to place at the bottom of the vessel a quantity of mercury, over which is the water, and to let the gas escape in the mercury, and below the water. This gelatinous silica, when dry, forms an exceedingly light powder. In fact, it is in a state of the extremest possible division. As far as I know, there is no other way of making amorphous silica in such a fine state of division as this.

The solubility of silica is a subject of very high importance to geologists. In an aqueous solution of potash, for two parts by weight of solid potash in solution there is dissolved one part by weight of this extremely fine silica in fluoride of silicon. Of silicon in the state of quartz there is dissolved ·009 for two parts by weight, and of silica in the state of flint there is dissolved ·038. This difference is due simply, or at all events in a great measure, to a difference of aggregation. When rock-crystal has been actually melted, and then pulverized, it is as soluble in this menstruum as the silica from the fluoride of silicon. Silica dissolves, to a certain extent, in water containing alkaline carbonates. The light variety is far more soluble than the heavy variety. An aqueous solution of carbonate of potash, or soda, for example, dissolves fifteen times more amorphous than crystalline silica. With regard to the solubility of silica in pure water, Bischoff states, that one part of silica dissolves in 769,230 parts of water.

Some results obtained by Professor Graham are as interesting as they are novel and important,—the phenomena of dialysis, which will possibly hereafter be found to explain many obscure geological phenomena.

Some paper, termed "parchment paper," is tied round a hoop of gutta-percha, forming a circular vessel, the bottom of which consists of parchment paper. Into a glass vessel place pure water, and into the hoop place a solution of silicate of soda to which acid has been added in such a way as not to precipitate the silica, then place it on the pure water, and leave it. What will take place? In the course of time a certain proportion of the silica will pass through that membrane into the other constituents in the solution, but eventually there will remain in the floating hoop, covered with the parchment paper, a pure solution of silica. All the hydrochloric acid will be gone by virtue of the operation of that paper. The chloride of sodium or potassium, as the case may be, will be gone,—with a certain proportion of silica, it is true,—and there will remain at length a pure, limpid, colourless solution of silica.

Amongst the illustrations supplied by Professor Graham for this lecture, was a 5 per cent. solution of silica. There was no base to retain that silica in solution. It was a pure limpid solution of silica in pure water. In the course of time, if the solution has a certain strength, it will gelatinize, or, as Professor Graham calls it, pectize—form jelly. The weaker and purer the solution, the less tendency it has to gelatinize. Professor Graham expresses an opinion, that with 1 per cent. of silica the solution might be preserved for an indefinite length of time without change.

There are some very curious properties about this solution to which the lecturer is very anxious to call the attention of geologists. This solution may contain as much as 14 per cent. of silica, and yet be perfectly limpid, and not in the least viscous. It may be boiled in a flask for a considerable time, and concentrated considerably without change. When heated in an open vessel, a ring of insoluble silica is apt to form around the margin of the liquid, and this may soon cause the whole to gelatinize. The solution is, as I said, durable in proportion to its purity. It is not easily preserved beyond a few days, unless considerably diluted. It becomes opalescent after a short time, and then the jelly separates; and once separated it cannot be redissolved in water. When the jelly is formed suddenly it is always more or less opalescent. Formed slowly, it is a jelly, perfectly colourless and limpid, like rock-crystal. If touched slightly it gives rise to a vibratory tremor. It contracts, after a few days, even in a close vessel, and then pure water separates from it. It is a very curious fact that coagulation, or the separation of silica in the jelly-like state, is effected in the course of a few minutes by a solution containing one ten-thousandth part of any alkaline or earthy carbonate, but not by caustic ammonia or neutral or acid salts, nor by sulphuric, nitric, or acetic acid. Coagulation occurs in a short time after passing carbonic acid through the solution. A little carbonate of soda to it will make it so solid that it may be inverted without spilling. When it is suddenly made so, it is always opalescent, and not transparent. Dried by the air-pump *in vacuo*, at the ordinary temperature, it forms a beautiful, transparent, glassy mass of great lustre, no longer soluble in water, and which reminds one greatly of that beautiful variety of opal termed "hyalite."

Ordinary silicate of soda is not at all what is termed "colloidal;" if silicate of soda were put into the hoop-vessel, and left there floating upon the water, it would pass through, to a certain extent, to the water, but there would be no separation of its constituents. When hydrochloric acid is added and the constituents eliminated, then this action is set up. This soluble form of silica unites with various organic matters, as, for example, with common gelatine, or with skin. In fact you may tan by means of silica, and produce leather containing as much as 70 per cent. of silica.

We will now inquire whether there is any reason to suppose that a similar process may play any part in the operations of nature. The condition required is a soluble silicate dissolved in water, and the decomposition of that silicate by some agent, such as hydrochloric acid. Does nature present us with any apparatus which can take the place of this so-called dialyser? All that we want is the porous bed of some rock like sandstone, in some convenient position, and that sandstone will act exactly as the dialysing apparatus.

In the separation of the silica every bubble of the fluoride of silicon as it passes up through the water becomes immediately decomposed, and a portion of the gas escapes, not being thoroughly in contact with the water everywhere, and produces a slight smoke. We have reason to believe that this solution may play an important part in the phenomena of nature; for there is no difficulty in explaining how such a solution may be obtained as is requisite to exhibit the phenomena of dialysis; and very probably in nature we may find conditions exactly suitable for dialysis. If this be the case, we shall be at no loss to understand how in many instances silicification has occurred. We know that it has occurred, and to an enormous extent, in nature. The mineral termed "opal" is nothing more than amorphous silica containing a little water. The proportion of water is not definite; it is variable, the extremes being somewhere about 3 per cent. and 13 per cent of water. Sometimes this opal exhibits most beautiful colours, and then it acquires the name of "precious opal."

These colours are due to a peculiar structural arrangement, and may be explained by the laws of optics. And if any one will examine the opal from Mexico and the substance prepared by evaporation *in vacuo* by Professor Graham's experiment, he cannot fail to be struck with the resemblance between the two. The mineral termed "hyalite" is also a kind of opal met with in basaltic rocks. It is another form of amorphous silica. This hyalite contains an amount of water, the extremes of which are 3 and 6 per cent.

The processes carried on in our blast furnaces or iron-smelting furnaces on so large a scale in various parts of this country, may really furnish indications of great importance to the geologist. In the hearths of blast furnaces is occasionally found a white, delicate, fibrous substance, to which the name of "fibrous silica" has been given. It has been carefully examined, especially by Rose, who finds it to consist essentially of silica. It is silica in the amorphous state, produced at a high temperature, and, therefore, having a specific gravity not exceeding 2·2 or 2·3. We are not perfectly certain yet as to the precise conditions under which it has been generated, but most likely it may have resulted from the oxidation of silicon. Sorby informs us that he obtained fibrous silica, exactly similar to that occurring in the hearts of blast furnaces, by passing fluoride of silicon, together with the vapour of water, through a porcelain tube heated to red-whiteness. By introducing the fluoride of silicon at one end of the tube, and the steam at the other, he obtained silica only in small vitreous grains. That is the amorphous silica.

In concluding this lecture, the lecturer said he could not help forestalling what he should say hereafter as to the formation of certain igneous rocks, especially of granite. For a long time it has been the received notion, that all granite, which occurs so abundantly in the crust of the earth, has been the result of igneous fusion at a very high temperature; but there are certain difficulties which have always been in the way of accepting this view of the subject,—difficulties known, at all events, to those who have been accustomed to make experiments on the fusion of mineral substances at high temperatures. Now, let us look at the fact of quartz occurring in this granite. Granite consists, as most of us know, of three minerals—quartz, mica, and felspar; and the quartz in it is crystallized, and always has the specific gravity 2·6. There is not a single instance known to the contrary. There is therefore reason to believe that that quartz never could have been fused; for we have seen that the moment we fuse silica, no matter in what state it was previously, we obtain a glass-like colloidal or non-crystalline mass, having a specific gravity never exceeding 2·3. In this fact he thought it would be agreed that there is something like a foundation for the inference (even from this single fact) *that such granite could never have been produced under the condition of a high temperature.* What those conditions were under which it was produced would be hereafter considered.

MANCHESTER GEOLOGICAL SOCIETY.—*24th November,* 1863.—A new safety-hook was described by Mr. George Wild, and the results of an attempt to get information from coal-proprietors twenty-four years ago, was brought before the meeting by Mr. Binney. It appears that to 250 circulars by the Society, only one reply was received,—from Mr. Ralph Thicknesse, of Wigan.

COLONIAL GEOLOGY.

AGE OF NEW SOUTH WALES COAL-BEDS.

By Mr. Daintree.

The 'Yeoman, and Australian Acclimatizer,' publishes an article on the "Age of the New South Wales Coal-beds," by Mr. Daintree, one of the gentlemen connected with the Geological Survey Department of this colony, from notes collected "during a three months trip from Melbourne to the Upper Burdekin, Queensland." One of the most important facts mentioned in these notes refers to the dispute which has been long pending between the Rev. Mr. Clarke, of New South Wales, and Professor M'Coy, as to the age of the New South Wales coal-fields. It must be satisfactory to Mr. Clarke to find that a gentleman of Mr. Daintree's experience and undoubted qualifications has done something towards turning the dispute in his favour.

The history of this dispute, says our contemporary, deserves attention. The Rev. W. B. Clarke, of New South Wales, has long been distinguished as one of the best practical geologists in this hemisphere. In numerous instances he pointed out where gold deposits would be found long prior to their actual discovery. He had also examined and reported upon the coal-strata of the sister-colony, and from a careful observation of the strata in position, and by the character of the fossil remains, he had arrived at the conclusion that some of the coal-beds of New South Wales are of the same age as the Lower Carboniferous series of Europe. Professor M'Coy, however, before he left England, had adopted a notion that the New South Wales coal is Oolitic, but that the marine fossils in the same neighbourhood, often found in contact with the coal-beds, are Lower Carboniferous. With a pertinacity almost amounting to stubbornness, Professor M'Coy has adhered to the notion he had formed. After the Professor removed to the southern hemisphere, he did not think it worth while to visit the coal-beds in dispute, but continued to controvert, often with unseemly and even reprehensible bitterness, the opinions of Mr. Clarke, who took an early opportunity of asking European geologists to suspend their judgment in the matter for a time, as he felt perfectly convinced of victory in the end. Mr. Clarke's argument was, that the coal could not be Oolitic and the marine fossils Lower Carboniferous, for in one locality examined—namely, Russell's pits, Stony Creek, Maitland (and at other places)—the coal-seams, with the plants in dispute, lie a long way *below the marine beds*. Some years ago Mr. Clarke sent a section of the coal-strata to the Royal Society of Victoria. Professor M'Coy and Mr. Selwyn rejected it, on the pretence that there was a "fault" in the strata; and in the opening address of the president of the society (Sir Henry Barkly) in 1861, judgment was given against the opinions of Mr. Clarke. Throughout the dispute, that gentleman has been often unfairly dealt with, and harder things have been said than have appeared in print. In vol. v. p. 107, of the Transactions of the Royal Society of Victoria, there is a passage in a paper by Professor M'Coy, pretending that Mr. Clarke told him and Mr. Selwyn that the specimen produced by Mr. Clarke in proof of his opinion was one of plants belonging to beds from which it had fallen, or might have fallen, from the top to the bottom of the shaft. Mr. Clarke replied to this statement, but it was afterwards repeated (*vide* p. 217, vol. v. of the Royal Society's Transactions), as if Mr. Clarke, who produced the specimen in proof of the age of the coal, could have admitted that all he had said was untrue. The 'Australian Yeoman' is convinced that Mr. Clarke is right, and congratulates him on his triumph over a stubborn foe.

Then follow the geological notes collected during a three months' leave of absence, spent in a trip from Melbourne to the Upper Burdekin, Queensland (with a plan and section), by Richard Daintree, field geologist, Victoria; the substance of which is,—

Starting from Melbourne, the Tertiaries of Port Philip Heads, the Amygdaloids of Cape Schank and Philip Island, succeeded by the cliffs of the Cape Paterson Carbonaceous strata, were rapidly passed. Next, the granite of Wilson's Promontory and the low sandy Tertiaries of Gipps Land. The promontory of Cape Howe was scanned, in the hope that it would afford some connecting link between the eastern extension of the Carbonaceous strata of Gipps Land and the southern coal-fields of New South Wales, but, from the distance no sign of stratified rocks could be discovered.

Kiama was the first point where sedimentary strata, traversed apparently by dykes of so-called "older basalts," met the view; they form part of the New South Wales coal-group. Here the Basalt relieves, with undulating slopes of rich agricultural soil, the usual sterile character of a Carboniferous area. From Kiama to Sydney, cliffs of sandstones of the coal-group afford sections showing the gradual ascent into upper beds, the "Hawkesbury Series" of Clarke, on which Sydney stands. Crocodile Head, six miles north from Jarvis Bay, is a worthy subject for an artist's pencil, so picturesque is the grouping of these rocks at that particular point. From Sydney to Newcastle, bold bluffs of the same formation give facility for studying this part of the series. From Newcastle to Stony Creek is but a short trip, and as there are sections on which Mr. Clarke bases his evidence of the Palæozoic age of part, at least, of the New South Wales coal-seams, it is one of the necessary pilgrimages for the wandering geologist in search of truth. What I saw there I will state in as few words as possible. I saw three shafts on Mr. Russell's estate—ladder-shaft, working-shaft, and 200 ft. shaft. Ladder-shaft is 19 ft. below the level, and 132 ft. west of working-shaft. Working-shaft is 9 ft. below the level, and 360 ft. north-west of 200 ft. shaft. The dip of the strata is east 6° south. Taking working-shaft as a pivot, ladder-shaft is 6°, and "200 ft." shaft 39° off the line of dip. Reducing these distances between the shafts to the corresponding distances on the dip, we have—ladder-shaft distant from working-shaft 132 ft. nearly, "200 ft." shaft distant from working-shaft 280 ft. For details of the various strata passed through in these shafts see Clarke's 'Discoveries in Australia,' p. 53. Four coal-seams were cut in the several shafts. We may distinguish them as the 5 ft. 7 in. seam, splint seam, working seam, and bottom seam. Now the working seam, No. 16 and 18 of Clarke, is removed between ladder and working shafts. The top of this seam is struck in ladder-shaft at 24 ft. 4 in., and in working-shaft at 92 ft. 4 in. The difference in level being 19 ft., will therefore give a dip of 49 ft. in a horizontal distance of 132 ft., or the relation of perpendicular to base of 1:2·7=dip of over 20°. As 5 ft. 7 in. seam crops at the surface of ladder-shaft, it will not afford safe data for calculation of dip between it and working-shaft. In "working" shaft top of 5 ft. 7 in. seam is met with at 60 ft. 9 in. from the surface, in "200 ft." shaft at 153 ft., or, subtracting 9 ft. for difference of level, at 144 ft. This gives a difference of 83 ft. 3 in. in 280 ft. horizontal distance, or the relation of base to perpendicular 1:3·363. In "working-shaft," bottom of working-seam, with 2 ft. parting of sandstone, is reached at 97 ft. 10 in., to which add 9 ft. difference of level = 106 ft. 10 in.; and in "200 ft." shaft bottom of same seam, with 5 ft. parting of sandstone, is reached at 187 ft. 1 in., which gives a difference of 80 ft. 3 in. in 280 ft., or relation of base to perpendicular 1:3·48. It will be seen from these figures that a higher dip prevails between "working" and "ladder" than between "working" and "200 ft." shafts, and also that the strata intervening between "5 ft. 7 in." and "working" seams vary in thickness, and that we cannot deal as with straight lines in the calculation of the general dip. I have therefore taken the mean between the dip of the "5 ft. 7 in." and "working" seam, between "working" and "200 ft." shafts, as the nearest approximation for calculating the outcrop of the different strata. This is 81 ft. 9 in. in 280 ft. The relation of perpendicular to base 1:3·425 = 16° nearly. This places the outcrop of the lowest stratum (Clarke's No. 25) at a point 993 ft. S. 6° W. from the top of Russell's "200 ft." shaft, supposing the surface of the ground at the same level. Outcrop of top of bottom seam, 794 ft.; ditto, working seam, 611 ft.; ditto, splint seam, 573 ft.; ditto, 5 ft. 7 in., 524 ft. And these are the positions assigned for the various outcrops in the accompanying plan and section. When the details of these shafts were first made known by Mr. Clarke as a proof of the Palæozoic age of the coal, *Spirifera Fenestella*, etc., being found in abundance above, and Glossopteris associated with and below the coal, it was suggested by Professor M'Coy, that the data given by Mr. Clarke showed the existence of a fault between "working" and "200 ft." shaft, and that possibly to this fault the reversion of beds might be due, but the Palæozoic character of the fauna was not called in question. This error arose from taking the absolute distance between the shafts (360 ft.) instead of the reduced distance to the line of dip of 280 ft. Referring to the extension of Russell's coal-seams to the northern railway, unfortunately at a point where no marked bed of Russell's series can be absolutely identified, we have an apparently unbroken series of strata dipping in the same direction, and at about the same angle, as those in Russell's coal-pits, extending from a point at 19 miles 72 chains from Honeysuckle Flat to 21 miles 37 chains from the same place, the beds furthest to the eastward dipping at a greater angle. This affords a thickness (taking the angle of dip at 16°) of 2365 ft. of strata, abounding in fossil fauna from bottom to top, very low down in which coal-seams with Glossopteris occur. Fossils from each of the cuttings on the railway and from Russell's shafts were procured, that palæontologists may satisfy themselves of their European parallel. If it be admitted that the fauna found in the upper strata of these shafts is Palæozoic, then these coal-seams, at least, are Palæozoic, and Glossopteris has a much lower range than has hitherto been assigned it, except by Mr. Clarke. Neither does there seem any reason why Mr. Clarke should not place the Newcastle coal-seams (his No. 3 Carboniferous group) in the upper portion of this Stony Creek group, no known unconformity existing, since no fauna or flora typical of the Mesozoic period has, I believe, yet been found in the said No. 3. This brings me to the consideration of Mr. Clarke's present arrangement of the Carboniferous series of New South Wales. First. "Wianamatta beds" with insignificant coal-seams, the upper beds of which are the probable equivalents of our Otway, Bellerine, and Wannon beds, in which Glossopteris has not yet been found. Second. "Hawkesbury beds," with insignificant coal-seams, and no Glossopteris. To this series Mr. Clarke refers the Grampian sandstones of Victoria, though Mr. Selwyn places them with No. 4. (By Grampian sandstones I mean the beds constituting the sierra.) Third. "Carboniferous beds," containing the workable coal-seams, with Glossopteris by far the most abundant fossil. In the lower portion of this series, four known coal-seams are interpolated with strata containing a fauna similar in character to that found in the Carboniferous Limestone of Europe. Fourth. "Lepidodendron beds," not associated with coal-seams as far as yet known. If this arrangement is correct, and my experience as a field geologist is entirely in its favour, it is of great practical value to us in Victoria in the search for workable coal-seams, and should cause us to direct our attention to the upper beds of the Avon series, Gipps Land, where No. 4 is so well developed, and also to Cape Liptrap, where Carboniferous Limestone is supposed to crop out, in the hope of finding the Glossopteris beds. It points unfavourably towards the Tæniopteris and Zamites bearing beds, which we have hitherto regarded as our coal-producers, but which, as yet, have yielded nothing better than the Cape Paterson seams. 4000 feet also of these same beds have been tested by boring in the Bellerine district and have yielded nothing approaching a workable seam.

In the collection of fossils forwarded by Mr. Clarke to Professor M'Coy, at Cambridge, specimens had been collected from the three upper divisions of the Carboniferous series of New South Wales; the subsequent division of the group had not then been worked out by that indefatigable geologist, and it is in this way, I believe, the mistake has arisen between Mr. Clarke and Professor M'Coy. Whether the fauna that overlies Russell's coal-seams is most assimilated to the Palæozoic or Lower Mesozoic forms of Europe, is a question on which I am not competent to form an opinion. When the question shall have been settled by palæontological authorities, it seems to me that little will have been done for the physical geologist at the antipodes, who must trust to the order of superposition, rather than to the palæontology, to work out the order of sequence, holding the opinion of Professor Huxley, that "there is no escape from the admission, that neither physical geology nor palæontology possesses any method by which the absolute synchronism of two strata can be demonstrated. That the moment the geologist has to deal with large areas, or with completely separated deposits, then the mischief of confounding homotaxis, or similarity of arrangement which can be demonstrated, with synchrony or identity of date, for which there is not a shadow of proof, under the term of contemporaneity, becomes incalculable, and proves the constant source of gratuitous speculations." All the facts that we have to guide the field-geologist in Victoria in his search for Clarke's No. 3 Carboniferous beds (containing the workable seams of New South Wales) are these,—that they are very low down in the Carboniferous series; that the lowest beds contain a fauna nearly allied to the Lower Carboniferous of Europe; that Glossopteris is associated with all the coal-seams, and is the most common and characteristic fossil of the said No. 3. This peculiar fauna or flora has not yet been observed in Victoria. Leaving now this most interesting piece of country and coasting along to Moreton Bay, under the lighthouse on Moreton Island we have sandstones, with a slight inclination, apparently, of the Carboniferous series cropping from under the Tertiary (?) sand of which the island is composed. If this is really Carboniferous Sandstone, Moreton Island may shortly become more valuable than its outward appearance would lead one to suppose. The rocks on which Brisbane stands may be referred to the Upper Silurian; they have generally a north-easterly dip at high angles, are traversed by numerous quartz veins, and gold would surely be found, though perhaps not in workable quantity, in the gullies around the city. If not covered by the Carboniferous series, as in the neighbourhood of Ipswich, we should expect richer deposits of gold in a south-westerly direction on getting into rocks lower in the Silurian series, that is supposing them still to retain their north-easterly dip. Passing out of Moreton Bay, and still going northerly, Tertiary sands of the Brighton series occupy low-lying country on the coast, the Glass House Peaks, said to be volcanic, raising their peaked heads from the plain with sharper outline than the craters of Ascension. At Double Island Point, the southern entrance of Wide Bay, Basalt underlies the Tertiary, and hence to Inskip Point are cliffs the exact counterpart in lithological character of the Red Bluff series, Brighton. The streets of Maryborough are metalled with soft sandstone, similar in appearance to the Melbourne beds, and fifteen miles in a south-westerly direction gold of a nuggety character is being found in quantity, and about a hundred diggers are employed.

Hence to Rockhampton the sandy tertiaries prevail along the coast. Under Woody Island, and at one point on Fraser's Island, Basalt is seen in places cropping from under the sand. Rockhampton stands on rocks which dip to the north-east at high angles. A quarry opened at the side of one of the streets exposes a fine section of these. They consist chiefly of altered slates with bands of impure limestone containing fossils, pronounced by Professor M'Coy as Palæozoic. The altered slates, almost Lydian stone in places, resemble those of Mount Staveley, Victoria. No quartz reefs were noticed in them. In the range of hills opposite Rockhampton, these same beds have a westerly dip, and splendid sections are afforded of the sequence of beds in the heads of the creeks running from these hills. Up the Fitzroy, about four miles above Rockhampton, a marble is quarried for lime-burning; it has a north-easterly dip, and appears to be nearly the uppermost stratum of the series exposed in the neighbourhood. Cornelians, some of large size, are found in the gravel drift of the Fitzroy at this point, probably washed from granitoid rocks exposed higher up that stream. Leaving Keppel Bay and going north among the islands, all is granite (Pentecost Island is one of the most remarkable in form). Generally they are pine-clad, and have a most picturesque appearance. The sail from Rockhampton to Port Denison is, indeed, one of the most charming it has yet been my fortune to undertake. Rounding Gloucester Island, a precipitous granite ridge, Port Denison, is reached.

The township of Bowen stands on Tertiary sand resting on a granitoid rock. The same geological feature extends along the coast northward to the Burdekin river, Cape Upstart, Mount Abbot, and numerous smaller peaks of granite rearing their heads above the Tertiary plains and alluvial swamps at their base; indeed, were the coast line submerged to the dividing range 200 ft. below the present level, it would present the same features as now obtain from the present shore to the Barrier Reef. At the lower crossing of the Burdekin, the cornelian-bearing granitoid rocks are again in force, and abundance of cornelians are to be found in the river sands. Following the present well-beaten track to the Valley of Lagoons at the head of the Burdekin—a track which twelve months ago did not exist, but is now as plain and well-worn as any in Victoria (the distances in miles marked on the trees)—for twenty-nine miles from the Lower Burdekin crossing, we pass over a level, sandy, Tertiary area, with large patches of swampy alluvium. At the twenty-seventh milestone Kill Bullock Creek is reached, on the east bank of which a well-defined quartz reef crops out from a matrix of rotten granite. This granite is exactly similar in character to that of Omeo and that of some portions of Tambo

River, Gipps Land. Frequently hornblende replaces the mica altogether; it is then this rotten character is most observed, and the decomposition itself has been so active in places, that at the forty-first milestone a fresh-water deposit of white limestone has accumulated to a very considerable thickness. At the forty-second milestone the summit of the coast range is reached. Hence to the fifty-third milestone, the last crossing of the Fanning river, these same granitoid rocks prevail. In the bed of the Fanning river gold of rather coarse character has been found, both by Mr. Ross, of the Fanning, and a party of miners who accompanied Mr. Brown, of Sydney, to open a supposed copper-lode in the neighbourhood. [The specimen given me by Mr. Brown was examined by Mr. Wood, at the Geological laboratory, and found to be specular iron ore.] Now this is exactly the character of granite described by Mr. Clarke, of Sydney, as gold-bearing; in fact it was from the description in his 'Southern Goldfields,' that I was led to give more than ordinary attention to this area, in hope of getting at some practical result.

My time would not permit me to prospect for myself, but I am of opinion that a less lucrative employment might be found than gold-washing in Kill Bullock Creek, and from there to the Fanning river the geological indications are equally favourable, supposing it to be a fact that granite of this description, or even quartz reefs in granite, are the matrix of gold. It is true that on the top of the coast range boulder-pebbles of rocks foreign to those *in situ* are scattered over the surface of the ground, and although denudation over this area has been very great, still I saw no sign of Silurian rocks in or near the Fanning; there are certainly none on the east side coast-range. This looks like one more example of the occurrence of "gold in granite." At about the seventieth mile from the Lower Burdekin crossing, the granites give place to limestones full of corals, with a lithological character, the exact counterpart of those of Buchan and Bindi, Gipps Land; they are as much contorted as these, but their most regular dip is N. 30°, E. 50°. The same physical outline is also here obtained, and Bindi, dotted with small clumps of scrub, overgrown with many-tinted creepers, to give variety to the landscape, would serve for a photograph of Cunningham's Burdekin Station. These limestones were either very thin originally or they have been greatly denuded, since the granite crops at the surface at intervals till we lose it altogether, and at the Upper Burdekin crossing regularly stratified pink and brown sandstones and breccias make their appearance, dipping south-westerly at an angle of 10° to 15°.

On the west side of the Burdekin, Basaltic lava veils the underlying rocks, but on crossing a deep cutting creek, six miles from the crossing place, these same pink sandstones occupy the bed of the creek, with a westerly dip at 15°. These sandstones I take to be the northerly extension of the Carbonaceous series, which I have Mr. Gregory's authority for stating extend from the junction of the Suttor with the Burdekin to Darling Downs. The usual section on the Buckland table-land, according to this authority, is—1. Basalt; 2. Upper Carboniferous Sandstone; 3. Coal-measures; 4. Limestones, with spirifers. I am indebted to Mr. Richardson, of Rockhampton (of Burns, Bassett, and Co.), for the information that a seam of coal 6 ft. thick crops in the banks of the Mackenzie, near Cooroorah station, with a general S.W. dip, resting unconformably on the conglomerates and sandstones of Mount Stewart.

From this Upper Burdekin crossing west to the watershed of the Flinders the country is entirely basaltic, Fletcher's Creek forming its main boundary on the south, and the Clarke river on the north, where the underlying rock is seen in the bed of "Basalt" or "Limestone" creek; it is of a granitoid character, but Mount Caroline, the southernmost peak of Perry's Range, is of altered slate, highly inclined, with numerous and broad quartz reefs on the flanks, the summit being composed of syenite, and this appears to be the character of the rocks of the Upper Clarke, though blue fissile slate with quartz reefs is more abundant there. Mr. Clarke has long ago pointed out this district as a future gold-field. The fulfilment or otherwise of the prophecy is at hand. It was from drifts overlying the Basalts of this district I obtained the bones of Diprotodon, the most northern part of Australia in which, at present, the fossil remains of this animal have been found. It is to these drifts that the cattle in the neighbourhood come to lick, and I am of opinion it is more for the phosphates from the bones of Diprotodon and his allies than from the chlorides they contain.

A well-defined crater exists at a point bearing S. 30° W. from Mount Caroline, distant 36 miles. From the top of this an excellent view is obtained of the boundary of the Basalt to the south. Granite spurs, gradually sloping to the southern side of Fletcher's Creek, have checked its further development in this direction.

Looking westward, we have a gradual rise to the table-land forming part of the watershed between the Flinders and Burdekin rivers, broken at intervals by low isolated peaks or ridges. From this point may be seen the Mount Mayne, etc., of Walker. South of this hill, about two miles, commences what is called a "Basalt wall." This is said to extend in a south-easterly direction as far as, and across, Fletcher's Creek, and I believe no one had up to that period penetrated above this up Fletcher's Creek. Where I struck it it had the appearance of a walled city ruined by an earthquake, the outer wall, though much rent, preventing the access of a horseman to the débris lying within. Creepers and shrubs of great variety grew over all, whilst a swampy bog at the base of its bluff margin, rich in ferns, promised on the whole a harvest for the botanist, a safe retreat for the blackfellow, and charming "little bits" for the artist or photographer. I regret much that I could not devote the time to following down this "Basalt wall," and more thoroughly exploring it. Whether it is the margin of an enormous crater, or a more recent lava-flow than that of the surrounding level country, I had not leisure to investigate. These Basaltic Lavas differ in no respect from those of probably the same age in Victoria; a suite of specimens collected on Keilor Plains and on the Upper Burdekin could not be distinguished the one from the other. A peculiar feature of the Basaltic country here is, that the banks of the main, deep-cutting creeks are very rocky, whilst the branch creeks are usually the drains of open, gently-sloping well-grassed downs; table-lands of lightly-timbered and usually coarser-grassed country intervening between the branch creeks. The timber on these table-lands is chiefly that known as "stunted ironbark," and a remarkable feature is the absence of fallen timber. This is attributable to the fact that the centre of nearly all the trees is hollow, making them an easy and certain prey to the first bush-fire.

Taking a general view of the geology of Queensland, as far as could be obtained in such a flying visit, and from the reliable information I could collect, it would appear that a belt of Upper Silurian rocks extends along the coast from Brisbane to the neighbourhood of Broad Sound, and that their strike being nearly parallel with the coast line, has mainly determined its outline. Their dip, where observed, is north-easterly, at a high inclination. The Maryborough and Rockhampton beds I would place at about the same geological horizon; lower in the series would come the gold-fields of Canoona, and those south-westerly from Maryborough, and to the strip of country beween these two gold-fields we should look for the extension of diggings. From the fact of these rocks being, as I believe, Upper Silurian, gold-fields of the type of Caledonia and Anderson's Creek are to be expected rather than those of Sandhurst and Ballarat. Silurian rocks again make their appearance at Mount Caroline, the southernmost peak of Perry's Ranges, Upper Burdekin. On the flanks of this hill their general dip is south-westerly. These rocks I should consider about the horizon of the auriferous series of Peak Downs, and that they represent the western portion of a great anticlinal axis, of which the Canoona and Maryborough beds represent the eastern. The dome of this axis has been denuded, and gone to form a portion of the material of that enormous carboniferous deposit which, as Mr. Gregory informs me, extends from the junction of the Suttor with the Burdekin southward to Darling Downs. From Broad Sound northerly to Mount Elliot, the coast range is of granite and its varieties, and in streams flowing exclusively through the granite, auriferous drift is found.

Whether the extension of the Silurian system over this country has been entirely removed, and the granite represents only the base of this supposed anticlinal dome exposed by denudation (as the objectors to gold in granite would probably argue), is, of course, uncertain; this much at least can be said, that the drift in which this gold is found is essentially granitic, and the resemblance to the granites of Omeo and Tambo River, Gipps' Land, is remarkable. Basaltic lava flows, of greater or less extent, are met with in various parts of the colony, *e.g.* between the Clarke river and Fletcher's Creek, the Valley of Lagoons, the Buckland table-land, Peak Downs, etc. Between the 19th and 20th parallels of latitude the greater part of the country seems to be occupied by it. The tract of country included between the Clarke and Fletcher's Creek has received its Basaltic covering from local craters, which form conspicuous landmarks only from high ground; they are too low to be seen in timbered country. The Basaltic areas are those best adapted for pastoral purposes in the tropics, their rich soils inducing the growth of the finer grasses with abundance of herbs, whilst their elevation above the sea renders the climate less enervating than that of the seaboard. From Mr. A. C. Gregory I learn that the representatives of our "older Basalts" of Philip Island, Cape Schank, etc., are found as dykes cutting through the Carboniferous series, and he draws the distinction (which holds in Victoria) between the Basaltic lavas of the plains and these, that the former were ejected from individual craters, the latter from fissures, forming dykes in rocks they traversed.

The geology of Queensland, therefore, seems to differ little from that of Victoria, except in the relative areas occupied by each formation, the neighbourhood of Fitzroy Downs, from which the Wollumbilla fossils have been received, affording the only prospect of novelty to the Victorian geologist.

NOTES AND QUERIES.

Devonians in North-East France.—It is well known that the Devonian rocks of the Meuse extend towards the Boulonnais, and are connected with that enormous line of dislocation and upheaval which has brought up the coal-measures and subjacent rocks in a direction from

Tournay to St. Omer. The researches of M. Gosselet, which have been recorded by him in a most able memoir on the Palæozoics of Belginm, published in 1860, and a few communications made by him to the Geological Society of France, leave little to be desired, either on the score of descriptive or comparative geology. Led by a desire to ascertain how far the appearance of the rocks representing the uppermost strata of the Devonian there shown agreed with our own Devonshire types, I made recently a brief excursion to Avesnes and Oltrungt. The former place may be reached by a pleasant walk of about four miles from Aulnoye, a station on the line to Maubeuge, or by country *diligence* from Landricies. On getting out of the Neocomian plains covered with loamy soil into the more diversified country near Avesnes, the cuttings begin to show a shivered rock of a snuff-brown colour, having a Devonian facies. The road-metal is evidently carboniferous limestone. This continues into the town, and thence southwards by the great road for about two miles, when a black massive limestone crosses the road, and is worked in the field adjoining in vertical beds. Fossils are scarce, but the series of beds are like those of Newton Bushel. Proceeding on to Oltrungt, and visiting the quarries so well described by M. Gosselet, we have undoubtedly the South Devon limestones and shales in full force, with abundant fossils. There are a few fossils of the Upper Devonian (Clymenia), and some of the Petherwyn forms, but on the whole the group is that of Plymouth and South Devon. The copious lists of M. Gosselet will furnish comparison with our own localities. The junction in the carboniferous limestone with the Devonian is nowhere shown, though quarries in each formation are wrought near to each other. But it is impossible for any one acquainted with the aspect of the latter in our own country to confuse the two here, as was done for many years here. The former is of the Tournay type, and characterized by *Productus semi-reticulatus* and other Tournay forms. The Devonian, as a whole, is characterized by *Phacops latifrons*, *Spirifer Verneullii*, *Orthis crenistria*, etc.

I had only a day to devote to Oltrungt, but it would repay a longer stay, and the extensions of the beds on the line of strike well deserve study. I could not detect any true apparent Devonian, or any Carboniferous beds below the Tournay limestone.—S. R. Pattison.

Boulder Drift at Marlborough.—In a personal note, Mr. Whittaker, of the Geological Survey, says, "In your review of Flora of Marlborough, I think you give a quotation, in which the Boulder Drift is said to occur in that neighbourhood. There is nothing of the sort there, and I expect that the faults noted are purely imaginary."

Errata.—In the description of the section, Plate I., Fig. 1. instead of "Section from Furze Hill to Farringdon," *read* "Section from Little Coxwell eastward, passing through the pits of Sponge and Red Gravel."—C. J. H. Meyer.

THE GEOLOGIST.

MARCH 1864.

ON SPIRAL PLANETARY ORBITS AND THE PHYSICAL EFFECTS OF A RETARDATION OF THE EARTH.

BY THE EDITOR.

WHEN we see the untenable deductions to which even such an eminent man as Professor Frankland is led, in his new glacial doctrines,* by basing a meteorological hypothesis upon the unproven basis of a central molten core in our planet, we cannot but be the more convinced of the necessity of reconsidering the theories and hypotheses which have been proposed to account for the origin and supposed early conditions of our earth. We have been called upon by geologists to reject the Mosaic cosmogony because its statements were not coincident with geological facts, and equally now are we called upon to examine what those asserted geological facts are, and whether the asserted superior theories of geologists are substantially correct, or whether they are one whit less mythical than the traditions of aboriginal peoples.

Because men saw what through their telescopes looked like luminous clouds, the elder Herschel and Laplace assumed the idea, still later urged by Nichols, that these celestial nebulæ were vast masses of ethereal vapours condensing into stars. Modern telescopes, however, constantly being increased in size and power, have resolved one after the other of these into wonderful star-systems—dust-clouds of brilliant suns. And has not every one of these far distant stars non-luminous planets and worlds rolling round it, as our earth and

* See Proceedings of Royal Institution, page 105.

its sister-planets round our sun? As baseless then as the fabric of a vision is the nebulous theory, ingenious undoubtedly and creditable to its authors as a suggestion, but every tittle of evidence to support it has vanished, and left not a wreck behind. We ask the supporters of this doctrine—for many still there are—to point out an instance of the evolution of light and heat by *slow* condensation of gaseous matter? If we fire hydrogen and oxygen, the condensation assumes the form of an explosion, light and heat are generated in a sudden flash, and the resulting drop of water is formed. If then the materials of the earth were derived from the condensation of gaseous matters in space, that condensation would be of the briefest period of time, not enduring for unaccountable ages,—the formation of our globe rapid and suddenly consummated. Was it so? If by loss of heat in condensation the solid and fluid materials of our earth were thus resolved into a globe, heat must have been the cause of the previous expansion of those materials into a gaseous state. Whence, then, was that heat derived? In the interior of our earth, where every atom of matter is subjected to pressure and chemical action, it is easy to see that in the natural order of the correlation of physical forces, motion and heat must be produced. And so far it is certain that in the natural and unavoidable changes which are there going on, heat *equal* to any degree of temperature yet observed in the deepest mines, or the waters of the deepest wells, may be constantly generated and maintained. If we take the meteorites which have fallen upon our earth and examine them, even the smallest are composed of solid earthy or metallic substances. May not these meteorites be the nuclei of worlds? If iron, potassium, sodium be in vaporous incandescence round the sun, why may not metallic particles exist in space? If solid materials, whether in almost infinitesimally mechanically-divided, or in vaporous or gaseous states, exist in space, segregation by such atoms is inevitable. Two or three united together by mutual affinity and attraction, would gather in time two or three more, and so on rushing through space they would ever gather like the snowball in weight and volume as they rolled. May we not ask, is not orbital and celestial motion ordained for the very purpose of world-increase—the gathering and segregating of more materials? Take this view, and you have the greatest and grandest of worlds formed as placidly as a rain-drop, and the mind is relieved of the puzzling incongruities of luminous condensation without explosion, and of internal cores of molten rock in every planet, without any source of fire to keep the melting up from age to age.

The notion of the resistance of the ether of space to planetary orbital motion, has been passing through other minds besides our own, and since we printed them we have read with much pleasure an article by Professor Henrichs, of Iowa, on the Density, Rotation, and Age of the Planets, in the 'American Journal of Science.' All the old astronomical notions of the old astronomers of the permanence of the heavenly orbs and the celestial system, still retained, and too closely and superstitiously adhered to, are based upon and must be based upon erroneous foundations. The permanence and endurance of heavenly bodies, and the perpetual rectification and everlasting persistency of their motions, must be based upon these assumptions:—1, that *space* is a *vacuum;* 2, that a body set in motion *in vacuo* will continue in motion *ad infinitum;* 3, that every form of motion must be an *accurate mathematical figure* perfectly and absolutely true, such as a circle, an ellipse, a straight line; and lastly, that there must never be any transportation or intercommingling of even the merest particles of matter between one world and another, nor *the least loss nor the least gain of material* from any planet or sun whatever, from the beginning to the end of time. The world at its creation must have been weighed in the balance, and not an ounce nor a feather's weight added to it since. Now we know there is ether in space; if there were not, the light of the sun would have no material to vibrate upon, and though the sun burned with ten times its glorious brilliancy, all would be darkness here, for it is scarcely possible to believe that light could travel in an absolute vacuum. We never get, experimentally, a perfect vacuum, pump as hard as we can; fit the joints of our instrument as close as we may, we never get one. It is always an atmospheric vacuum, a nitrogen-vacuum, a hydrogen-vacuum, an ether-vacuum,—always some residue; never a vacuum at all, however near it may approach,—always some material particles, no matter how expanded, for the vibration of light to thrill along, and this the electric spark and the spectrum-prism will always show. If the ether of space exist,—and astronomers who adhere strongest to the old notions admit it,—there must be resistance. The more subtle the ether, the more delicately slight the resistance, but still resistance; and with resistance comes friction, with friction retardation and the evolution of heat. With retardation of orbital motion the diameter of the planet's orbit must be contracted. The world might—most probably would—run round the sun up to the very same line, radiating from our luminary to the same hour, minute, and second, but not to the same spot, but to a spot nearer, no matter how slightly nearer, to the sun, although upon the same straight line, and so year by year the circumference of the orbit would be ever constantly contracting; and what must be the inevitable result?—a *spiral* orbit!

Now, let us consider what would be the physical results of this retardation producing a spiral orbit. If the retardation be ten feet annually,—we will take it hypothetically as such for the present, and to still further simplify the proposition we want to put, we will also take for the present a perfectly circular orbit, because by so doing we shall get a total result *at once*, instead of having to eliminate a total result from a period of duration. If the earth be retarded ten inches a month, the total retardation would be ten feet for the year, so we may assume, for simplicity of explanation, a full total at once. Now, then, if the earth were thrown back in her orbit suddenly for ten feet, what effect would her momentum exert upon her constituent material particles? Would not every one of these particles have a tendency to fly on, and would not this tendency produce tension and inter-particle motion, and thence, of course, friction, rearrangement, crystallization, upheaval, and subsidence of masses, and *internal heat?* Has the internal heat of our globe any other source than results from the constant retardation of our earth in a spiral orbit? And is not the primary physical force which evolves all, or principally all, structural alterations and constituent rearrangement of rock-masses? And if so, is not this force calculable? If the earth be retarded ten feet per annum, will not this force be equal to the momentum of the mass of our globe for the time our globe takes to pass through ten feet of space? Given this rule, can we not estimate the quantity of heat that would be evolved? It seems to me we can; and as by such a cause the temperature of the *whole* of the interior of the earth beneath that mere rind, subject to solar and atmospheric variations, might be and would be equally warmed to a certain point, whatever that may hereafter be determined to be, and thus the internal heat would be naturally accounted for by natural phenomena. And even if it should be found that this cause should be a sufficient source for an intense degree of heat,—and it is possible it may be,—we should be relieved of much of the embarrassment which the internal heat theory provokes, because we never can get its theorists to assign a natural and intelligible cause for its production and maintenance.

ON THE FORAMINIFERA OF THE LONDON CLAY.

By Professor T. Rupert Jones, F.G.S., and W. K. Parker, Esq.

In 1833, T. N. Wetherell, Esq., of Highgate, discovered several Foraminifera in some London Clay taken from a well at the Lower Heath, on the south side of Hampstead; see Proceed. Geol. Soc. vol. ii. 1834, p. 93, and Transact. Geol. Soc. 2 ser. vol. v. p. 131. In plate ix.; one of the two plates accompanying Mr. Wetherell's paper in the Geol. Transactions, these Foraminifera, with other small fossils from the clay, were figured by Mr. J. De C. Sowerby, by whose help also the determination of the fossils was made.

At page 135 of Mr. Wetherell's paper, the figured Foraminifera are referred to as "Nodosaria, pl. ix. figs. 3–7; Articulina, figs. 8–10; Marginulina, fig. 12; Rotalia, figs. 13–18; Cristellaria, fig. 19; Miliola, fig. 20." Fig. 11, doubtfully referred to "Frondiculina," is not a Foraminifer, but probably the cast of the palettes of a *Teredo*; a similar fossil is figured and thus designated by D'Archiac in the Mém. Soc. Géol. Franc. We have seen, in Mr. Wetherell's collection, the Foraminifera from the well above-mentioned, as well as others from the London Clay of Hampstead, Highgate, and Finchley. We possess a large series of picked specimens collected by Mr. John Purdue from the London Clay of the Copenhagen Fields, Islington, when the cuttings for the Great Northern Railway were being made; also some from the London Clay of Finchley, Chelsea (bed of the Thames), and Clapham; and a very fine suite of specimens from Wimbledon Common (out of the clay at about 100 feet in depth). The last-mentioned series is probably a nearly complete local Foraminiferal fauna; for very many pounds of the clay were minutely examined, and there are only one species, and three varieties of two other species, to be added from our other gatherings from the London Clay.

With regard to the figured specimens from the well near Hampstead, the following is our determination of the species and varieties; most of the latter, however, as well as the real species, have distinct names, as is common and convenient with Foraminifera:—

Geol. Trans. 2 ser. vol. v. pl. ix. fig. 3. *Dentalina Buchi*, Reuss, d. g. Ges. Zeitsch. ii. pl. iii. fig. 6. The specimen, still preserved by Mr. Wetherell, shows the characteristic, minute, longitudinal riblets crossing the septal constrictions, but not seen in the figure. This is not an uncommon variety in some Tertiary deposits.

Fig. 4. *Dentalina elegans*, D'Orb. Foram. Foss. Bas. Vien. pl. i. fig. 52. This is a fragment of one of the manifold subvarieties or individual modifications of *D. communis*, D'Orb., which has abundant representatives in the living and fossil states.

Fig. 5. *Dentalina spinulosa*, Montagu, Test. Brit. Suppl. pl. xix. fig. 5, p. 86. A fragment, figured upside down. A similar fragment, figured and described by Montagu, obtained by Mr. Boys from the

sea-shore of the south-east of England, and long thought to be recent, has been referred by us to the London Clay. (Annals Nat. Hist. 3 ser. vol. iv. p. 346.) Differences in the development of the little prickles constitute the chief distinctions of the closely allied forms *D. spinulosa*, Montagu, *D. Adolphina*, D'Orb., *D. spinescens*, Reuss, *D. spinosa*, D'Orb., and *D. spinicosta*, D'Orb., in all of which the longitudinal riblets, so characteristic of well-grown Nodosarinæ, are modified as spines and prickles; whilst in another closely allied set of forms, the prickles are less regularly arranged in rows, and of varying strength; namely, in *Nodosaria hirsuta*, D'Orb., *N. rugosa*, D'Orb., *N. punctata*, D'Orb., *N. aculeata*, D'Orb., *N. hispida*, D'Orb., *N. conspurcata*, Reuss, *N. aspera*, D'Orb, *Dentalina aculeata*, D'Orb., *D. floscula*, D'Orb., *D. scabra*, Reuss, *Marginulina hirsuta*, D'Orb., and *M. cristellaroides*, Czjzek. The modifications of form, from the straight Nodosaria, through the bent Dentalina, to the still more curved Marginulina, do not any more represent *specific* differences than the modifications of the exogenous riblets and prickles. Nor do the differences in the relative size and gibbosity of the chambers afford more distinctive characters; but all these features are subject, one with another, to endless gradual transitional modifications in the Nodosarinæ. *D. spinulosa* and its subvarieties are exceedingly common in the London Clay and in the Septarien-Thon of Germany and other Tertiary beds.

Figs. 6 and 7. *Textularia (Verneuilina) communis*, D'Orb. The figures do not distinctly exhibit the peculiar triangular apex of the shell; a feature arising from its being at first a triserial *Textularia* (*Verneuilina*), before it grows with a single line of chambers only, so taking a Nodosarian shape. The shell is rough with grains of sand cemented into its substance; a structure affected by Textularia and some other genera, but not by Nodosarina. It was mistaken by one of us for a Nodosaria, and named *N. rustica*, Jones, in Morris's Cat. Brit. Foss., 1854, p. 37; and Montagu evidently had specimens (derived from the London Clay) before him when he described and figured the "Nautilus Radicula," Test. Brit. p. 197, pl. xiv. fig. 6 (not pl. vi. fig. 4); see Ann. Nat. Hist. 3 ser. vol. iv. p. 344 and p. 350. This elongated dimorphous Textularia is one of D'Orbigny's Clavulinæ (*Clavulina communis*, For. Foss. Vien. pl. xii. figs. 1, 2); other "Clavulinæ" are elongated Uvigerinæ and Valvulinæ (see Ann. Nat. Hist. 3 ser. vol. v. p. 469). This little Foraminifer is very common in the London Clay and in some other Tertiary deposits; and it still lives in the Mediterranean.

Fig. 8. *Nodosaria Badenensis*, D'Orb. For. Foss. Vien. pl. i. figs. 34, 35. This is a modification of the usually more regular *N. Raphanistrum*, Linn.; indeed, the increase of size in some of the chambers is so variable, that there is no real ground for the separation of this from the next form, with which it is associated in considerable abundance in the London Clay, and several other Tertiary deposits. The specimen figured is a fragment.

Fig. 9. Three chambers of the long, cylindrical, ribbed *Nodosaria Raphanistrum*, Linn., the same as *N. Bacillum*, Defrance, *N. æqualis*,

Sow., *N. affinis*, D'Orb., etc. Common in the London Clay, the Vienna basin, the subapennine Tertiaries, the Malaga, San Domingo, and other clays, and recent at Jamaica.

Fig. 10. *Nodosaria Raphanus*, Linn. This is less developed compared with the foregoing, and is equally, if not more abundant in the recent and fossil state. Its modifications are endless, and its names proportionally numerous. There is no real demarcation either between *N. Raphanus* and *N. Raphanistrum*, or between them and their subvarieties, however modified as to size and number of riblets, closeness or division of the chambers, conicity or cylindricity of the shell, its straightness or curvature, or the more or less central position of the aperture. Gradual changes lead us, on one hand, to the costulate and prickled Dentalinæ and Marginulinæ above referred to; and, on the other, to the smooth *Nodosaria radicula* and *Dentalina communis;* whilst Vaginulinæ, Marginulinæ, and Cristellariæ, with and without riblets, come out, as it were, from the straighter forms without any real *specific* differences, however convenient it may be to retain distinct names for nearly all the modifications alluded to.

Fig. 12. *Marginulina Wetherellii*, Jones, in Morris's Catal. Brit. Foss. 1854, p. 37. Montagu had this little shell also in the Boysian Collection, doubtlessly from the cliff-washings of Kent, and referred it, erroneously, to what is now known as a narrow variety of *Peneroplis planatus*. It is one of the most common of the Foraminifera of the London Clay, and though somewhat similar Marginulinæ occur in other Tertiary beds (San Domingo), and even in the Chalk (of Mecklenburg),* and the Clays of the Oolites, yet it remains as a distinct variety. It had a peculiar habit of ending its growth with one or more simple, contracted, smooth, dentaline chambers, figured both by Montagu and Sowerby.

Fig. 13. *Cristellaria cultrata*, Montfort. A common, nautiloid, keeled Cristellaria, common in many deposits, both of Secondary and Tertiary age, and abundant in the living state in the existing seas at many places. When the keel is wanting, we have *C. rotulata*, Lamarck; when the shell is large-keeled and rowelled, it is *C. Calcar*, Linn.; when flattened and broad, it is *C. Cassis*, Fichtel and Moll.

Figs. 14–18. These little Rotaline shells are small varieties of *Planorbulina farcta*, Fichtel and Moll (Ann. Nat. Hist. 3 ser. vol. v. p. 177, etc.). They range between the varieties figured and described by D'Orbigny as *Rotalia Haidingeri* and *R. Ungeriana;* and Reuss's *R. ammonoides*, D'Orbigny's *R. Akneriana* and *R. Dutemplei*, are scarcely, if at all, divisible from *R. Ungeriana*. All of these abound in the present oceans. Another near modification of this form is shown in the well-known *Planorbulina (Truncatulina) lobatula*, Walker and Jacob, which also occurs in the London Clay, though not so plentifully as the foregoing, and frequents shallower water than they do.

* *Cristellaria decorata*, Reuss, Zeitsch. d. g. Ges. vii. pl. viii. fig. 66, and pl. xix. figs. 1, 2.

FORAMINIFERA OF THE LONDON CLAY OF MIDDLESEX AND SURREY.

Genera, Species, and Varieties.	Wetherell's Collection.		Collections of Messrs. Parker and Jones.			
	Hampstead Well.	Highgate, Hampstead, Finchley, etc.	Copenhagen Fields, Islington.	Chelsea (bed of Thames).	Clapham.	Wimbledon Common.
Miliola (Biloculina) depressa, D'Orb.	...	...	...	...	...	rr. s.
——— *(Triloculina) oblonga*, Montagu	...	...	r. s.	...	...	rc. s.
——— *(Quinqueloculina) triangularis*, D'Orb.	+	+	c. s.	...	...	c. s.
Trochammina incerta, D'Orb.	+	...	c. l.	...	...	r. l.
Lituola nautiloidea, Lamarck	...	...	rc. rs.	rc. m.	...	...
Nodosarina (Nodosaria) Raphanus, Linn.	+	...	...	...	...	vr. vs.
——— ——— *Raphanistrum*, Linn., and *Badenensis*, D'Orb.	+	...	c. rl.	...	c. m.	c. rl.
——— ——— *Ovicula*, D'Orb., and *longiscata*, D'Orb.	...	...	c. m.	rr. m.	...	rc. rs.
——— ——— *Pyrula*, D'Orb.	...	...	rc. m.	rr. s.	...	rc. s.
——— ——— *Radicula*, Linn., and *humilis*, Roemer	...	..	rc. m.	rr. m.	...	rc. rs.
——— ——— *hirsuta*, D'Orb.	...	...	...	...	...	vr. s.
——— *(Dentalina) communis*, D'Orb., and *elegans*, D'Orb.	+	...	rc. rs.	c. rs.	...	c. s.
——— ——— *consobrina*, D'Orb., and *pauperata*, D'Orb.	...	...	c. m.	...	rr. s.	c. s.
——— ——— *brevis*, D'Orb.	...	...	...	...	...	rc. s.
——— ——— *Buchi*, Reuss	+	...	...	...	...	...
——— ——— *acicula*, Lam.	...	...	rc. m.	...	r. m.	rc. l.
——— ——— *spinulosa*, Montagu	+	...	c. m.	...	c. l.	c. m.
——— ——— *acuticosta*, Reuss	...	...	...	...	...	rr. s.
——— *(Vaginulina) linearis*, Montagu	...	...	...	...	...	rc. s.
——— *(Marginulina) Lituus*, D'Orb.	...	...	rc. rs.	...	...	r. s.
——— ——— *Wetherellii*, Jones	+	+	c. l.	c. l.	c. l.	c. l.
——— *(Cristellaria) cultrata*, Montfort, and *rotulata*, Lamarck	+	+	rc. m.	...	c. m.	c. l.
——— ——— *Cassis*, F. and M.	...	...	...	...	...	rc. l.
——— ——— *Italica*, Defr.	+	...	c. m.	...	...	...
——— ——— *Crepidula*, F. and M.	...	...	...	...	...	r. s.
Globigerina bulloides, D'Orb.	...	...	...	...	...	rr. s.
Pullenia sphæroides, D'Orb.	...	...	...	...	...	r. s.
Textularia agglutinans, D'Orb.	...	...	rc. rs.	r. s.	...	c. s.
——— *Turris*, D'Orb.	...	...	r. rs.	...	...	...
——— *abbreviata*, D'Orb.	...	...	...	...	...	r. s.
——— *carinata*, D'Orb.	...	+	rc. m.	c. m.	...	c. m.
——— *(Verneuilina) communis*, D'Orb.	+	+	c. m.	c. m.	...	c. l.
Bulimina ovata, D'Orb.	...	...	rc. m.	c. m.	...	c. m.
——— *(Bolivina) punctata*, D'Orb.	...	...	...	...	...	vr. s.
Planorbulina Haidingeri, D'Orb.	+	...	+ ?	rc. s.	...	c. m.
——— *Ungeriana*, D'Orb.	+	+	+ ?	rc. m.	r. s.	c. m.
——— *ammonoides*, Reuss	...	...	...	rc. m.	...	c. l.
——— *(Truncatulina) lobatula*, Walker and Jacob	...	+	...	...	...	r. s.
Pulvinulina elegans, D'Orb.	...	...	...	r. vs.	...	r. m.
——— *Micheliniana*, D'Orb.	...	...	...	...	...	rr. m.
Rotalia orbicularis, D'Orb.	...	...	...	r. s.	...	r. s.

Fig. 19. *Cristellaria Italica*, Defrance (D'Orbigny's Modèles,* nos. 19 and 85). This is not an uncommon form where Cristellariæ abound, either in the recent or the fossil state.

Besides the foregoing, we have seen *Trochammina incerta*, D'Orb., among the specimens from the Hampstead well, in Mr. Wetherell's collection.

The London Clay from Wimbledon Common was got at about 100 feet in a well-boring. That from Chelsea came from the foundations of the Battersea Park Bridge.

The Foraminifera of the London Clay indicate a depth of about 100 fathoms for the sea, in which it was deposited in this district.

The accompanying Table shows the Foraminifera that we have recognized in the London Clay, arranged according to the classification proposed by Dr. Carpenter in his 'Introduction to the Study of Foraminifera,' 1862. The asterisk indicates their presence merely (the relative abundance not being known); their frequency and condition are shown in some of the columns by the following letters:—*rc.* rather common; *c.* common; *rr.* rather rare; *r.* rare; *vr.* very rare; *vs.* very small; *s.* small; *rs.* rather small; *m.* middle-sized; *rl.* rather large; *l.* large. In some instances two very closely related, but still notable, varieties are mentioned together.

CUTTINGS FROM A NOTE-BOOK ON CHALK GASTEROPODS.

By Harry Seeley, F.G.S.

Two years ago, collecting matter for future use, in travelling over the Chalk-lands, I made, in the museums visited, such brief memoranda of striking fossils as might save the trouble of comparison with other specimens. The notes were never intended for publication in their present form, but as any more extended work on the subject is at present impossible, such of them as I have permission to print may be found useful to others engaged on similar work.

This series is part of the magnificent collection in the Brighton Museum; to the Committee of which I am indebted for the opportunity of making use of them.

Cerithium ornatissimum, *var.*

Conical, twice as high as wide. Many-whorled; whorls flat and narrow, being four times as wide as high. Each whorl is ornamented on the upper and lower sutural margins by a very numerous row of closely-placed tubercles. The anterior row has the tubercles elongated longitudinally; those of the posterior row are more bead-like. Connecting these rows are half as many again narrow, sharp, upright ribs. The tubercles

* A set of these can be seen in the British Museum.

and ribs become not only actually, but relatively much more numerous as the shell enlarges; they are crossed horizontally by a number of (about ten) fine spiral striæ. The base makes a right angle with the spire, as in many recent species it is prolonged much in front of the side of the whorl.

This form nearly resembles *C. ornatissimum*, Desh., and is possibly its lineal representative. The differences of ornamentation are such as constantly are produced by the conditions of existence. The unequal spiral rows of tubercles of *C. ornatissimum* become in this form equal, and pass round the spire contiguous, so as to conceal the suture. In this form the excessive multiplication of the elongated tubercles of the anterior row tends in the last whorl to make that row less distinct; a similar character is also to be noticed in the adult of the French species. The longitudinal ribs of this variety exist in the species from the Gault only as striæ. The basal prolongation of the lip is, however, a feature in the chalk-marl form which will keep the two varieties from being confounded.

A second slight variation is met with not rarely in the lower argillaceous chalk of Burwell, in Cambridgeshire. It more closely resembles the foreign type than the Brighton specimen. In it the posterior row of tubercles is placed on an elevated rib; while the anterior row, at least on the anterior half of the shell, is wanting, being represented by rather elongated thickenings of anterior ends of the very fine striæ which replace the longitudinal ribs.—(*Woodwardian Museum.*)

Cerithium.

A very elongated cone, three times as high as wide. Rather few whorled; whorls flat, more than twice as wide as high. Each whorl is ornamented with three spiral rows of rather small, sharp tubercles, about twelve to fourteen on a whorl in each row. The tubercles are so placed as to form rows nearly perpendicular, or rather parallel to the labial side of the spire. Throughout the shell the spiral rows are at equal distances apart.

Cerithium Gallicum (*D'Orb.*), var.

A greatly elongated cone, three times as high as wide, many- (about 12-) whorled; whorls inflated, with an elevated mesial angle, from which they become smaller anteriorly and posteriorly, towards the sutures; the posterior half of each whorl is flat, but the anterior half is slightly convex. The posterior sutural margin is bordered by an elevated rib, which bears a numerous row of closely-placed tubercles. The part of the whorl between the suture and the suture-like anterior margin of this rib is nearly four times as wide as high; the whorl is one-third as high as wide. A row of sharp, elevated tubercles surmounts the mesial angle of the whorl. The whole spire is finely cancellated, the longitudinal striæ being stronger than those transverse. The base is convex, and separated from the whorl by a slight angular inflation.—(*Woodwardian Museum.*)

This differs from the French form chiefly in the small size and number of tubercles on the mesial angle, and is what some authors would regard as a representative species.

Pleurotoma amphiloga (n. sp.).

Shell elongated, 5- or 6-whorled; spire much elevated, two and a half times as high as wide, turreted; whorls elevated, nearly as high as wide, sides parallel with the sutural shoulder rounded. The whorls are ornamented with moderately elevated, narrow, longitudinal ribs, which increase in number, though not in size or closeness, with the growth of the shell. The body-whorl is slightly inflated, and the ribs upon it are wider apart and relatively less numerous than on the whorl above; they are crossed by numerous close, spiral striæ. The canal is broken, but the body-whorl could not have been less than twice as long as wide, *i. e.* half the length of the shell.

Although the mouth is not seen, the body-whorl, from which the shell is partly removed, shows beyond doubt the lines of growth characteristic of the genus. The "notch" in the lip appears to extend almost, if not quite, to the suture. It is the only species of the genus possessing the area-railing-like ornament, externally more like a Rostellaria.

FUSUS TRACHYS (n. sp.).

Shell fusiform, rather less than three times as long as wide. Spire elevated, less than half the length of the shell, composed of four or five whorls. Each whorl is twice as wide as high, and banded by two wide, thick, much elevated ribs, the space between which is hollow, and the spaces above and below become constricted and hollow on approaching the whorls they respectively adjoin. The body-whorl, like those preceding it, attains its greatest width at the band of the second rib. Anterior to this are three other ribs, the more anterior two of which are closer together than the others; and anterior to these are several very much smaller and closer together.

The whole shell is marked by close, fine, spiral striæ, which, on the smaller whorls, are often crossed by others in the direction of the axis. The mouth is extremely elongated and very narrow, lips being nearly parallel.

CHEMNITZIA WOODWARDI (n. sp.).

Shell subcylindrical, two and a half times as high as wide, consisting of about seven whorls, which regularly increase in size and are moderately convex. Each whorl is one and three-quarter times as wide as high. The space where the whorls adjoin is concave, and the suture is indistinctly seen. There is no ornament, but a great number of fine, close, spiral striæ.

This and some other shells have quite an Oolitic aspect.

SOLARIUM ORNATISSIMUM (n. sp.).

Depressed, few-whorled, nearly twice as wide as high; composed of about four or five whorls, which somewhat rapidly increase in size, and are five times as wide as high. Marginally the whorl is angular, and on the spiral surface there bordered by a narrow concave groove, which is margined on the inner side by an elevated rib. Above and interiorly there is another hollow space less deep and twice as wide, and near to the suture a row of about fifteen large, expanded, tumid, nearly adjacent tubercles. The base is gently convex and ornamented by close, spiral striæ. The whole of the upper surface is spirally striated, but the striæ are very much finer than those of the base; they are cancellated by equally fine, oblique striæ, which are directed backwards from the suture. The marginal groove of the whorl gives to the spire a marked sutural channel.

This looks very like a Pleurotomaria, but I think it is a Solarium.

PTEROCERAS, representative of FITTONI.

Shell elongated, about half as wide as high.* Spire less than a third the length of the shell, composed of about four whorls. Each whorl is more than a third as high as wide, and has round its middle a sharp, prominent angle; the part of the whorl above this is inclined at an angle of 45°, that anterior to it is perpendicular. The inclined part is

* The specimen, which is broken, is two-thirds as wide as high.

banded by five or six striæ, and the upright portion by four or five. In the body-whorl the space posterior to the angle is subconical, for a second angle, which in the smaller whorls is the limit of the upright part, and also the line of suture, is here reduced to a rib. Posterior to this keel are about eight spiral striæ.

In form this closely resembles *P. marginata* (D'Orb.) and *P. Fittoni* (Forbes).

Pleurotomaria Jukesii (n. sp.).

Few-whorled, subconical, moderately depressed, half as high as wide, consisting of five elevated whorls, which regularly increase in size. The whorls are nearly four times as wide as high, and each twice the diameter of that which preceded it. The filled-in sinus is elevated like a string and situate on the upper part of the whorl, which it divides into an upper and a lower region. The upper is very convex, deeply impressed at the suture, horizontal, and rather narrower than the lower region, which is flat and oblique, being inclined at an angle of about 60°. The slit of the sinus is equal in length to the diameter of the shell. The whole of the upper side is marked with very fine and close spiral ribs.

Under side not seen.

Most nearly related to *P. perspectiva* in form of whorl, but well distinguished by its few whorls.

Trochus.

Shell conical, three-fourths as high as wide; composed of about four whorls, which are flat, one-fourth as high as wide, and have the sutures deeply impressed. Each whorl is ornamented with four spiral striæ, of which each supports a row of sharp, elevated tubercles. The tubercles are separated by spaces about as wide as those which divide the rows. The tubercles of the anterior rows are successively placed one between two tubercles of the row above, so that other oblique rows are formed parallel to the labial side of the shell. The base is flat and spirally striate.

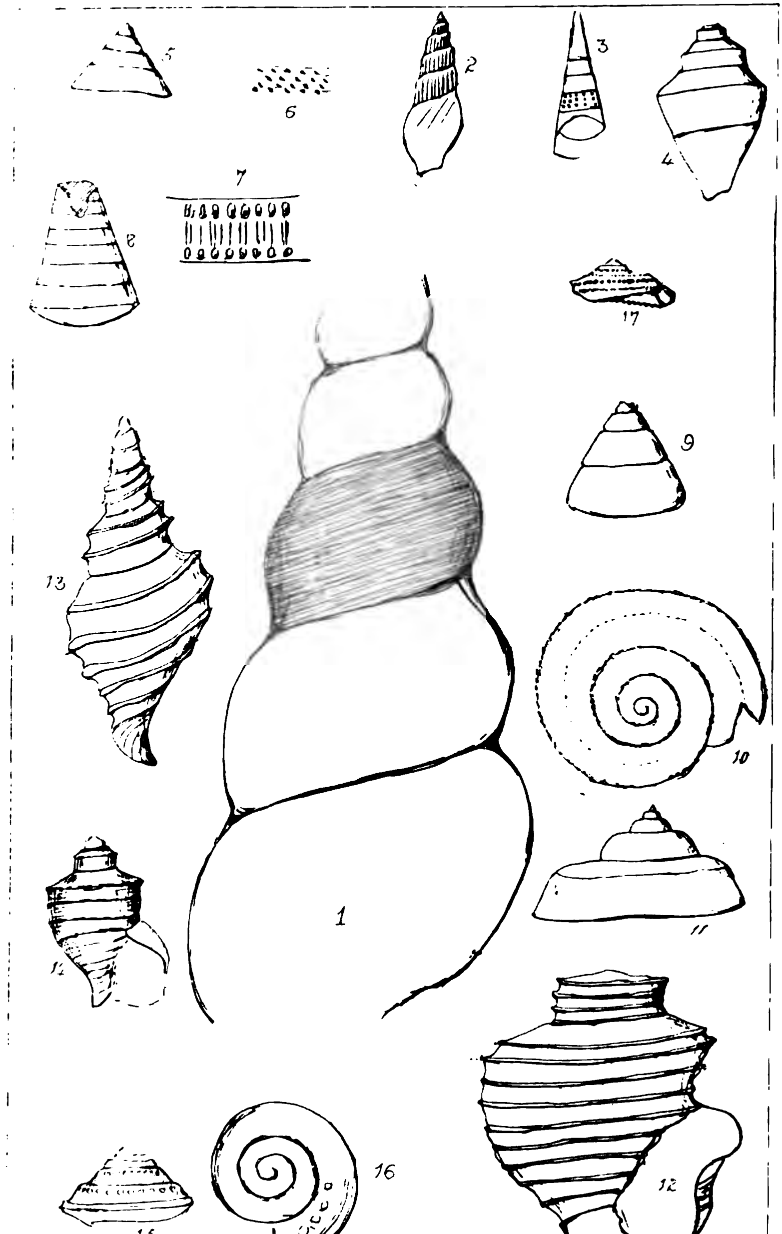
Trochus.

Conical, a little higher than wide, not umbilicated; commonly composed of four or five whorls, which are slightly convex. Each whorl is about two and a half times as wide as high and encircled by about six spiral striæ, which are elevated like cords; the interspaces are much wider than the ribs; they are flat. The highest rib is larger than the others, and in most cases less projecting; it and all the other costæ are crossed by very numerous, oblique, narrow indentations, giving to each rib the look of a twisted rope. The side passes under to the base in a large curve. The base is marked by a greater number of striæ than the side; they are less elevated, rather closer together, and not bead-like. Shell rather thick. The suture is wide and deeply impressed.

Very nearly related to *T. Geinitzii* (Rss.).

(?) Fusus.

Subangularly fusiform; composed of four or five whorls. Spire nearly half the length of the shell. Whorls angular, rapidly enlarging, twice as wide as high. Ornamented with four sharp, narrow, rather elevated ribs, below which, towards the columella, are a number of fine striæ, rather distant apart. The whorls are so coiled that two (? one) of the four costæ are covered by the body-whorl. The most prominent rib is the most posterior, which projects like a cord. The space between it and the suture is flat and inclined at a small angle, and the space below it, for half the body-whorl, is parallel to the axis. The slope of the ledge of the upper part of the whorl appears to become greater as the shell increases in size. Mouth pear-shaped. The shell is finely striated spirally, there being some twelve lines between two ribs, and these striæ are crossed by still finer



FAC-SIMILES OF MR SEELEY'S SKETCHES OF CHALK GASTEROPODS.

lines of growth. In a young state the shell is longitudinally ribbed, the ribs being tumid and close together; no trace of this is seen in the adult.

A second specimen, probably of the same species, is rather larger, and has a rib between the suture and the marginal angle, and six primary ribs on the body-whorl.

Both these examples are distorted by pressure. The smaller example (figured) is compressed laterally. The rock is a very hard chalk, much resembling some of the lighter-coloured clay concretions; fossils are yellowish.

(?) Fusus.

This form differs from the Brighton specimens chiefly in the large number of equal-sized ribs, a character to which little importance can be given; it may be varietal, but more probably is but an adult ornament, just as are the longitudinal ribs, a feature peculiar to the young. The lip is a little inflected. The space between the posterior two ribs appears to have supported a sharp projecting keel, now broken away.

Solarium Binghami (*Baily*).

Shell thick, much depressed, not half so high as wide; composed of about six whorls, which very gradually increase in size. The upper side of the shell is a greatly depressed cone; the under side a large conical hollow. The whorls are five-angular; they are attached by one side, two converge inferiorly to form the base, one perpendicular forms the side of the shell, and the fifth forms the slightly oblique upper surface.

This last form of the upper surface of the whorl is ornamented marginally by upwards of forty tubercles, which are elongated in a direction at right angles with the line of growth. A second row, more numerous and much smaller, passes round near to the suture. Both the interspace and tubercles are finely striated spirally. The perpendicular side is not more than half the width of the outer basal space; it has on its lower margin a row of tubercles similar to that on its upper margin, but they are narrower and half as numerous again. The tubercles so entirely occupy the side that the groove between the two rows is not half so wide as either of them. The outer part of the base is very finely cancellated; the angle it makes with the inner half is nodulated with seventeen large tubercles. The inferior suture is much more impressed than the superior one, and the sutural margin of the base is ornamented with a row of tubercles, about as numerous as that on the upper margin of the side. The umbilicus is nearly as deep as wide.

ON THE DENUDATION OF ARTHUR'S SEAT.

By James Haswell, M.A.

"Quid magis est saxo durum? quid mollius unda?
Dura tamen molli saxa cavantur aqua."

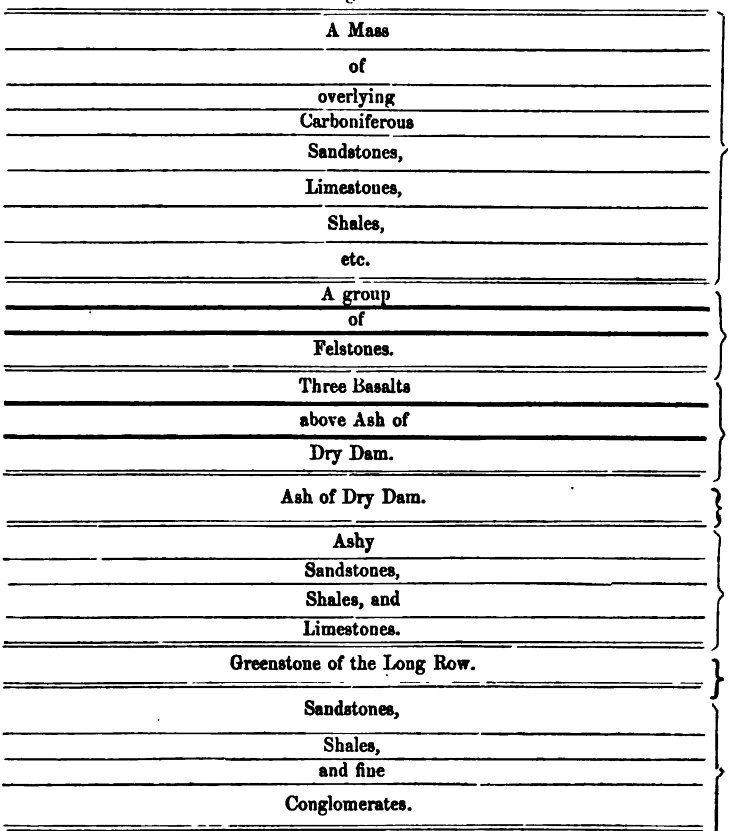
The condition of Central Scotland during the long period represented by the Secondary formations is involved in darkness. On the east and west coasts of Scotland rocks of Secondary age occur north of the Grampians, but of the physical history of *Central* Scotland during the time these rocks were deposited, we know nothing. From the time of the deposition of our Upper Coal-beds, or, it may be, of some Permian Sandstones, up till the time when the whole island was locked fast in one immense mantle of ice, we are almost entirely ignorant of what was going on in that part of the country which lies between the Grampians and the Forth. And the man who shall decipher for us the physical geography of that period, and reveal to us the old surface of that district, with its vegetation and animal productions, prior to the time of the Boulder Clay, will have rendered no small service to the cause of Scottish geology.

But although we have not as yet been able to trace the old surface of the land, we are not altogether without data to guide us in our researches. One thing is clear and certain,—a great change was taking place over the whole face of this region.

Both during and after the deposition of the coal-measures, great volcanic agencies were at work. In the neighbourhood of Edinburgh they were particularly active. They had been so during the Old Red Sandstone period, and contributed in no small degree to the formation of the Pentland Hills. But towards the close of the Old Red period and the commencement of that time when our Lower Carboniferous Sandstones were being formed, the Pentland ridge began to sink under those Carboniferous seas. The crater of eruption, which had been so active in the Pentland area, and produced that varied mass of material now presented to us as sheets of felstone and ashy bands, became gradually quiescent, till at last it was entirely covered over with the increasing deposits. But, while these deposits were being accumulated, the igneous forces broke out again at Arthur's Seat. Most of the rocks which now form the eastern part of the hill belong to this period. The greenstone of the Long Row, the red nodular ash and the thin bands of red ashy sandstone to be seen in a section at the south side of the Queen's Drive, the green felspathic ash of the Dry Dam, the black columnar basalt above it (which also constitutes the crag on which stands St. Anthony's Chapel), the two basalts behind St. Anthony's, and which form the *lower* part of Dunsapie Hill and Calton Hill, and lastly, that group of felstones which form the remainder of the eastern part of the hill from the *top* of Dunsapie across Whinny Hill to St. Margaret's Station, and which make up most of the Calton Hill,—all these igneous productions were *contemporaneous* with the Lower Carboniferous strata, and are found *interbedded* with them. Consequently, all these traps are *subaqueous*. Layers of sediment were first formed, then an eruption of lava took place, which spread itself in sheets over the strata; then more layers of mud and sand were deposited by the ocean, and then more sheets of lava ejected by the igneous agency below. It is evident, moreover, that these traps must have been more or less horizontal, for if they had been poured over an *inclined* surface, they would have collected in masses at the foot of the declivity,—a state in which we do not now find them.

THE LOWER CARBONIFEROUS STRATA AND INTERBEDDED TRAPS OF ARTHUR'S SEAT, IN THEIR ORIGINAL POSITION.

Fig. 1.



The Beds indicated by thin lines are Carboniferous strata; those by thick lines are Interbedded Traps.

In this way the elevating processes continued their unceasing work, stratum after stratum was deposited, sheet after sheet of lava ejected and consolidated, until, when the last of the porphyritic felstones had been produced, the igneous centre gave signs of cooling, and all became comparatively quiet. Then the sediment of these Lower Carboniferous seas accumulated over the solidified lavas, ganoid fishes revelled undisturbed in the Burdiehouse Estuary, and plants peculiar to the period were entombed in the mud; while, as the result of all, after many ages had elapsed and hundreds of years had passed away, an immense series of strata was elaborated, which extended continuously over the site of the Pentlands. The same waters under which was laid down the ash of the Dry Dam, and which held in solution the substances which fill the amygdaloidal cavities of the greenstones and felstones above it, also deposited above these rocks an enormous series of beds, 3000 ft. thick at least, of sandstone, shale, and limestone, the edges of which are seen on the beach eastwards from Portobello. and at East Cairn Hill on the Pentlands, at a height of 1839 ft. above the level of the sea, *i. e.* 1000 ft. above Arthur's Seat. These rocks also extend northwards into Fife. This is represented in the accompanying diagram.

It is perfectly evident then, from what has been already said, that Lower Carboniferous strata must have been elaborated far above the present altitude of Arthur's Seat, and that their area extended for a considerable distance on all sides, overlying the whole ridge of the Pentlands. It is also pretty clear, both from the horizontal beds of sandstone on the summit of East Cairn Hill, and from the state of the case generally, that these strata were at first laid down in a horizontal position, or at all events very nearly so.

Now, the *next* stage through which these rocks passed is easily determined. An *upheaving* movement must have taken place, by which the whole beds of the hill, already alluded to as forming the eastern part, on to the centre of the Musselburgh basin, were raised into the *inclined* position in which we *now* find them. If evidence of this upheaval is wanted, we have only to point to St. Leonard's Craig, Salisbury Craigs, with the two dykes cutting through them, and the Dasses, the only intrusive traps of the hill, and all found on the *western* side. The effects of this upheaval are well displayed at Salisbury Craigs, where the beds have an easterly dip, being raised on the west and depressed on the east, and where both the sandstone and the greenstone are altered in colour and texture at the point of contact. Indeed, nothing shows the intrusive character of this trap more clearly than the seam of shale to be seen at the south end of the Craigs, very much hardened and broken, lying completely enveloped in the greenstone. After this eruption, then, the rocks of the hill would present somewhat the appearance given in the accompanying diagram, Pl. V. Fig. 1.

But this is not the present aspect of the hill; Carboniferous strata no longer conceal the trap-rocks from view. How, then, have they disappeared? What has become of them? The answer is, *denudation* must have taken place. Now I think it is a fact which can be easily demonstrated, that Arthur's Seat has been subjected to denudation at *two* different periods.

First Period.— After the upheaving of the strata, already referred to, the beds, of course, were set on their edges (as in preceding figure), and were much fractured. The faults, too, which are so abundantly met with in the coal-measures, were no doubt produced by this upheaval. Consequently, in this state, the strata were more easily exposed to the action of tides and oceanic currents. The upper part of the hill, consisting of softer strata than the traps beneath, would soon be swept away and the waste material deposited in some other place; while the lower part of the hill, the traps themselves, owing to their hardness and tenacity, would resist the action of the waves more, and so stand out in bold relief above the softer Carboniferous strata. This is represented in the accompanying diagram; in fact, this is exactly the appearance which a section through the north end of Arthur's Seat would present, if the rocks round the summit were taken away (Pl. V. Fig. 2). We shall have occasion to refer to these rocks presently; but it is now well known that the volcanic ash or trap-tuff round the summit, the basalt of the summit itself, the columnar basalt of the Lion's Haunch, and the porphyritic felstone which forms part of the ridge descending from the summit into the south end of the Dry Dam, are each and all of them of a more recent age than the other traps of the hill.

Now if it can be shown that these *later* igneous rocks cover over and rest upon the *denuded* edges of the *older* traps and the Carboniferous strata, what other conclusion is open to us but the one already alluded to, viz. that after a great mass of Carboniferous strata had been deposited on the top of the interbedded traps, and after these had been tilted up into their present position by the eruption of St. Leonard's Craig, Salisbury Craigs, and the Dasses,—the whole of these rocks, being still under water, were subjected to marine denudation, and the waves, tides, and currents aided by the atmosphere, the springs, and the frosts, and performing their functions exactly in the same way as we see them now, gradually swept away the softer material, and left the harder traps as prominent crags? We find the later ash filling up the valley between the Long Row and the Dasses, and hanging down into the Hunter's Bog, which it must have once filled, as it could not stop short there; consequently these *valleys must* have been *eroded* before the ejection of the ash. This tells its own history. Moreover we find the same ash covering over the Long Row, the Dasses, and the greenstone seen in a section at the south side of the Drive (which is a continuation of the Long Row), and all these must have existed as *prominent crags* when the ash and the scoriæ fell around them. In the bed of the Firth of Forth also, many traps project from the coal strata which are known to form its channel,—Inch-Garvey, Inch-Colm, Cramond Island, Inch-Keith, Fidra, Craigleith, and the Bass Rock.

The denudation we speak of was not confined to Arthur's Seat alone. It extended over a larger area. The Pentland Hills which lay submerged under the same sea also suffered from it, the Roman Camp Hill also, and indeed the whole surrounding area of the Lothians. It has been calculated that the Carboniferous strata which covered the Pentlands and Arthur's Seat amounted in thickness to 8000 feet, but supposing they were only 5000 feet thick, this, with the present average height of the Pentlands, at 1000 feet above the surrounding country, would give us as the amount of material removed, a quantity corresponding to *five* times the existing mass of the Pentlands, and as these hills are 14 miles long by 8 broad, that mass must have been equal to 42 cubic miles.

This great denudation must evidently have required a long lapse of ages for its completion. While Permian and Secondary rocks were being deposited in other parts of the island, as, for instance, Oolitic rocks on the east and west coasts of Scotland, north of the Grampians, and Permian and Trias in the south, the central part of Scotland was undergoing a great change. No strata apparently were being elaborated, many however were being swept away; the work of abrasion and demolition was everywhere dominant. The softer strata of sandstone, shale, and limestone were carried off, and the numerous trap-rocks of the district left standing out in high relief, till in short the country began to assume very nearly its *present* appearance. The first period of denudation then is ended, and another period of volcanic activity is at hand.

Second Period.—Midlothian, still under water, is subjected to the ravages of a submarine volcano. The Tertiary period has come, and the igneous forces round Edinburgh, so long quiescent, so many millions of years at rest, which had not disturbed the neighbourhood since the Lower Carboniferous age, again become vigorous, again break out on the site of the old volcano. One can almost fancy the scene. The sky begins to lour, a rumbling noise is heard, and the crater of Arthur's Seat sends forth from its mouth showers of scoriæ and volcanic ash. As it fell over the truncated edges of the older rocks of the hill, large fragments of the sandstones, greenstones, basalts, porphyries, and amygdaloids were embedded in the felspathic paste, and soon converted into conglomerate when cooled. Then the crater of the summit was plugged up with solid basalt, and the volcanic material not being able to find a vent, burst out through a lateral orifice and formed what is now the Lion's Haunch. Last of all, another ejection of lava took place and wrapping round the north-east end of the basalt gave rise to the felstone of this part of the hill, and closed for ever the eruptions of Arthur's Seat (Pl. V. Fig. 3).

The hill however does not present the same appearance to-day that it did then. The ash must have fallen thickly over the site of Edinburgh, as is evident from the *fragmental* condition of the cliff of ash above Hunter's Bog, and also of the basalt on the slope at the south side of the hill, which never could have stopped abruptly there. Consequently we are led to conclude that Midlothian has been subjected to *another* process of denudation, subsequent to the ejection of these rocks. What was the nature of *this* denudation? It cannot have been due to atmospheric causes, nor to the action of the waves of the sea. Its true cause must be sought for in the *Glacial period*, when another change of contour was effected on Arthur's Seat. The greenstones and basalts were ground down and polished by the friction of the moving ice, the loose ash was swept away, and only that part of it left which had been more firmly compacted round the heated orifice of the summit (Pl. V. Fig. 4).

Fig. 1.

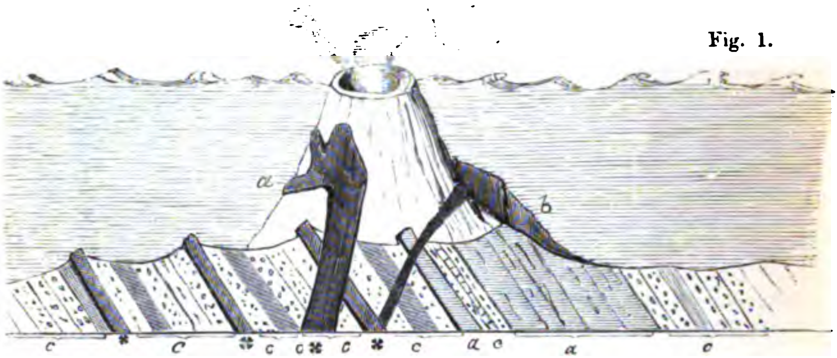


Fig. 2.

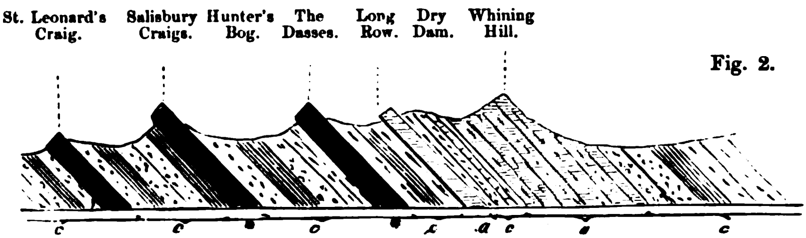


Fig. 3.

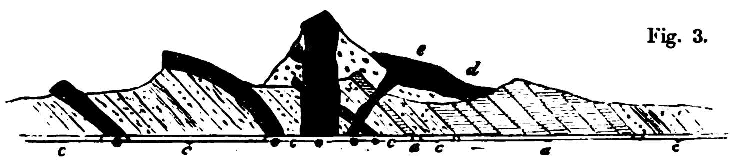
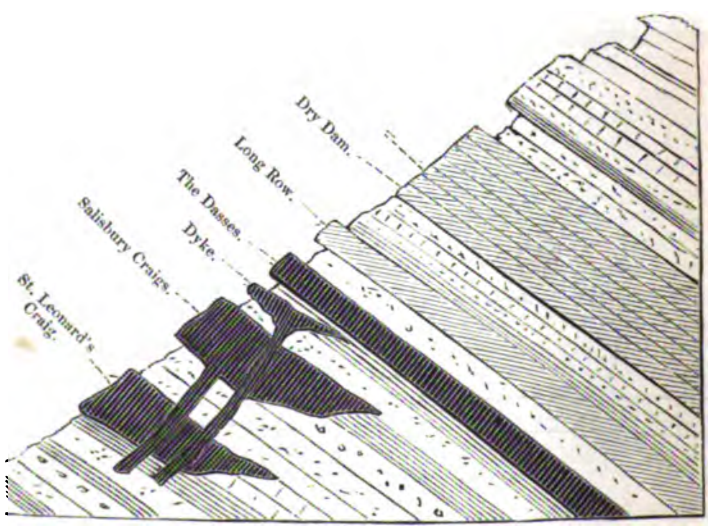


Fig. 4.



DENUDATION OF ARTHUR'S SEAT.

I need not now allude to the evidence we have for *glacial* action on Arthur's Seat. The groovings and markings above Sampson's Ribs and elsewhere, the number of greenstone and sandstone boulders scattered up and down in various parts of the hill, the "crag and tail" contour of the hill, and the character of the drift accumulated on the east side, are all familiar to the Edinburgh student of geology, and point to a time when, after remaining for a long period locked in ice, Arthur's Seat sank far below the sea-level, and when ice-borne blocks from the Highlands were dropt on the slopes of the Pentlands.

EXPLANATION OF PLATE.

Fig. 1. The Lower Carboniferous strata and interbedded traps of Arthur's Seat upheaved by the intrusive traps.

Fig. 2. The Lower Carboniferous strata and older traps of Arthur's Seat of the marine denudation.

Fig. 3. Submarine volcanic cone during the Tertiary (?) epoch, ejecting ash-scoriæ, etc., and producing the later Igneous rocks of Arthur's Seat. The cone of coarse volcanic ash and conglomerate. *a*. Basalt of summit; *b*. Basalt and Felstone of Lion's Haunch.

Fig. 4. Present appearance of Arthur's Seat after glacial action.

a Volcanic Ash, Trap, etc. * Trap, etc. *c* Carboniferous strata.

A LIST OF TYPICAL AND OTHER FIGURED SPECIMENS OF FOSSIL VERTEBRATA IN THE BRITISH MUSEUM.

(This list does not profess to give the title of every work in which the figures are reproduced or copied, but only of those in which they first appeared, or of such as may be used for general reference.)

I. MAMMALIA.

HUMAN SKELETON.—*Post-Tertiary*, Guadaloupe.—Phil. Trans. 1814, p. 107, pl. 3.

Palæospalax magnus (lower jaw).—*Pleistocene*, *Freshwater*, Bacton, Norfolk.—Owen, Brit. Foss. Mam. 1846, p. 25, f. 12.

Canis (Vulpes) vulgaris, Brisson.—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 134, f. 51, 53.

Galecynus Œningensis, Owen.—Quart. Journ. Geol. Soc. 1846, vol. iii. p. 55, f. 1, 3, 5; (*Canis Vulpes*, Murch. and Mant.), Trans. Geol. Soc. 1830, vol. iii. p. 277, pl. 33, 34, f. 1–3; (*Canis palustris*), Mey., Fauna der Vorwelt, Oeningen, 1845, p. 4, pl. 1.

Mustela (Plesictes) Croizeti, Pomel (lower jaw).—*Miocene*, St. Gerand-le-Puy.—Bull. Soc. Géol. Franc. 1847, tome iv. ser. 2, p. 385, pl. 4, f. 4.

—— *(Plesiogale) angustifrons*, Pomel. — *Miocene*, St. Gérand-le-Puy. — Bull. Soc. Géol. Franc. 1847, tome iv. ser. 2, p. 385, pl. 4, f. 3; Pictet, Paléontologie, 2nd edit. 1853–7, pl. 4, f. 7.

Putorius ermineus, Linn.—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 116, f. 40–42.

Hyæna spelæa, Goldfuss (lower jaw).—*Cavern*, Gailenreuth.—Cuvier, Oss. Foss. edit. 1836, pl. 192, f. 9.

—— *spelæa* (diseased skull).—*Cavern*, Muggendorf.—Owen, Brit. Foss. Mam. p. 154, f. 59.

Hyæna spelæa (part of lower jaw).—*Pleistocene*, Walton, Essex.—*Ibid.* p. 151, f. 58.
Felis Issiodorensis, Croizet and Jobert.—*Pliocene*, Mt. Perrier.—Oss. Foss. du Puy-de-Dôme, 1828, pl. 4, f. 4.
Felis pardinensis, Croizet and Jobert.—*Pliocene*, Mt. Perrier.—Oss. Foss. du Puy-de-Dôme, 1827, pl. 7, f. 2.
Felis brevirostris, Croizet and Jobert.—*Pliocene*, Mt. Perrier.—Oss. Foss. du Puy-de-Dôme, 1828, pl. 6, f. 6, 9.
Felis spelæa, Goldfuss (portion of upper jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 161, f. 63.
Ursus spelæa (lower jaw).—*Pliocene*, Bacton, Norfolk.—Owen, Brit. Foss. Mam. p. 106, f. 35 *c*.
Meles Taxus, Linnæus.—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 109, f. 37.
Arvicola amphibia, Linn. (upper and lower jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 201. f, 76.
—— *pratensis*, Owen (upper and lower jaw).—*Cavern*, Kent's Hole, Torquay.—Brit. Foss. Mam. 1846, p. 208, f. 78.
—— *agrestis*, Flem. (lower jaw and leg-bone).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 206, f. 77.
Trogonotherium Cuvieri, Fischer (lower jaw).—*Pleistocene*, *Freshwater*, Bacton, Norfolk.—Owen, Brit. Foss. Mam. 1846, p. 184, f. 71; Mantell, Petrifactions, p. 358, f. 74.
Lepus timidus, Linn. (lower jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 210, f. 80.
—— *cuniculus*, Linn. (lower jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 212, f. 81.
Lagomys spelæus, Owen (fore part of skull).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss, Mam. 1846, p. 213, f. 82, 84.
—— *Meyeri*, Von Tschudi.—*Pliocene*, Oeningen.—(*Anœma Œningensis*), König, Icones Foss. Sect. 1825, pl. 10, f. 126.
Carterodon sulcidens, Lund, sp. (cranium).—*Cavern*, Brazil.—Waterhouse, Nat. Hist. Mam., vol. i. p. 351, pl. 16, f. 7.
Glyptodon tuberculatus, Owen (tail sheath).—*Pleistocene*, Buenos Ayres.—Mantell, Petrifactions, 1851, p. 359, f. 75.
Megatherium
Mastodon Ohioticus, Blumenb. (lower jaw).—*Pleistocene*, North America.—Phil. Trans. 1768, pl. 4, f. 1; Falc. and Cautl., Fauna Ant. Sivalenis, pl. 3, f. 9; pl. 35, f. 4, 5; pl. 40, f. 16.
—— *angustidens*, Cuv.—? unknown.—Falc. and Cautl. Fauna Ant. Siv. pl. 40, f. 7.
—— *latidens*, Clift.—*Miocene*, Ava.—Falc. and Cautl. Fauna Ant. Siv. pl. 31, f. 1, 3, 4, 6–8; pl. 40, f. 1–3.
—— *Andium*, Cuv.—*Pliocene*, Buenos Ayres.—Falc. and Cautl. Fauna Ant. Siv. pl. 35, f. 3; pl. 40, f. 10–14.
—— *Perimensis*, Falc. and Cautl.—*Miocene*, Perim Island.—Fauna Ant. Siv. pl. 31, f. 9, 10; pl. 38, 39, f. 1–3; pl. 40, f. 4.
—— *Arvernensis*, Croiz. and Job.—*Miocene*, Eppelsheim.—Falc. and Cautl. Fauna Ant. Siv. pl. 36, f. 11; pl. 40, f. 6.
—— *Arvernensis*, Croiz. and Job. (upper molar).—*Mammaliferous Crag*, Whitlingham, Norfolk.—Smith, Strata Identified, 1816, frontispiece; Owen, Brit. Foss. Mam. p. 276, f. 97; Falc. and Cautl. Fauna Ant. Siv. pl. 36, f. 8.
—— *Sivalensis*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 3, f. 10; pl. 18A, f. 6; pl. 32, 33, 34, f. 2, 3; pl. 35, f. 1; pl. 36, f. 2, 5; pl. 37, f. 1–4, 6, 7; pl. 39, f. 4–6.
Elephas Cliftii, Falc. and Cautl.—*Miocene*, Perim Island.—Fauna Ant. Siv. pl. 30, f. 5.
—— *bombifrons*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 25, f. 2, 3; pl. 26–28, 29, f. 1, 2, 4, 6; pl. 29A, f. 1–5, 7; pl. 29B, f. 6, 7.

Elephas Ganesa, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 3, f. 7; pl. 21, 22, 22 A, f. 1, 2; pl. 24, f. 3–5; pl. 24 A, f. 1; 25, f. 1; pl. 25 A, f. 1, 2, 4, 5, 7.
—— *insignis*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 2, f. 6; pl. 15, 17, 18, f. 1–6; pl. 18 A, f. 3, 5; pl. 19, f. 1–6, 8; pl. 19 A, 20 A, f. 4, 7; pl. 24 A, f. 2; pl. 25, f. 4; pl. 29 B, f. 8.
—— *insignis*, Falc. and Cautl.—*Pliocene ?*, Central India.—Fauna Ant. Siv. pl. 56, f. 10, 11.
—— *insignis ?*, Falc. and Cautl.—*Pliocene ?*, Central India.—Fauna Ant. Siv. pl. 56, f. 12–14.
—— *planifrons*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 2, f. 5; pl. 6, f. 5–6; pl. 8, f. 2; pl. 9, 10, 11, f. 2–10; pl. 12, f. 2, 5, 7, 8, 11–13; pl. 14, f. 8, 9; pl. 18, 18 A, f. 1, 2.
—— *meridionalis*, Nesti.—Dredged off Happisburgh.—Falc. and Cautl. Fauna Ant. Siv. pl. 14 B, f. 13.
—— *meridionalis*, Nesti.—*U. Tertiary*, Val d'Arno, Tuscany.—Falc. and Cautl. Fauna Ant. Siv. pl. 14 B, f. 10.
Elephas priscus, Goldfuss.—*Unknown*.—Falc. and Cautl. Fauna Ant. Siv. pl. 14, f. 6, 7.
—— *Hysudricus*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. , f. 3; pl. 4, 5, 6, f. 1–3; pl. 7, f. 1–8, 12; pl. 8, f. 3, 5; pl. 13 A, 13 B, f. 7; pl. 14, f. 10.
—— *Hysudricus*, Falc. and Cautl.—*Pliocene*, Central India.—Fauna Ant. Siv. pl. 12 C, f. 6.
—— *antiquus*, Falc.—*Pliocene ?*, Gray's Thurrock, and other British localities.—Fauna Ant. Siv. pl. 12 D, f. 4; pl. 13 A, f. 5; pl. 14, f. 1, 2; pl. 14 A, f. 3, 5, 8, 10, 12, 13.
—— *antiquus*, Falc.—*Pliocene*, Via Appia, Rome.—Fauna Ant. Siv. pl. 14 A, f. 13.
—— *Namadicus*, Falc. and Cautl.—*Pliocene*, Central India.—Fauna Ant. Siv. pl. 13, 12 A, 12 B, 12 C, f. 1–5; pl. 12 D, f. 1–3; pl. 24 A, f. 4; pl. 48, f. 1; pl. 56, f. 1–4.
—— *Columbi*, Falc. }
—— *Texianus*, Blake } —*Pleistocene*, Texas.—Geologist, Vol. V. p. 57, pl. 4.
—— *Armeniacus*, Falc.—*Pleistocene ?*, Armenia.—Nat. Hist. Rev. 1863, p. 73, pl. 2, f. 2.
—— *primigenius*, Blum.—*Pleistocene*, Eschscholtz Bay.—Beechey, Voy. of the 'Beagle,' 1831, vol. ii. p. 593, pl. 1, 2.
—— *primigenius*, Blum.—*Pleistocene*, Bacton, Norfolk.—Falc. and Cautl. Fauna Ant. Siv. pl. 1, f. 1.
—— *primigenius*, Blum. (lower jaw).—*Pleistocene*, Worms, Hesse Darmstadt.—Falc. and Cautl. Fauna Ant. Siv. pl. 13 A, f. 2.
—— *primigenius*, Blum.—Unknown.—Falc. and Cautl. Fauna Ant. Siv. pl. 13 A, f. 3.
—— *primigenius*, Blum.—*Pleistocene*, Yarmouth, Norfolk.—Owen, Brit. Foss. Mam. 1846, p. 221, f. 86.
Vertebræ, bones of the extremities, etc., of *Proboscidia*.—*Miocene*, India.—Falc. and Cautl. Fauna Ant. Siv. pl. 46–55.
Dinotherium Indicum, Falc.—*Miocene*, Perim Island.—Journ. Geol. Soc. 1845, vol. i. p. 360; Fauna Ant. Siv. pl. 36, f. 6.
Rhinoceros Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 73, f. 3; pl. 74, f. 5, 6; pl. 75, f. 5, 6.
—— *palæindicus*, Falc. and Cault.—*Miocene*, Sewalik Hills.—Fauna Ant. Siv. pl. 74, f. 1, 3, 4; pl. 75, f. 2–4.
—— *platyrhinus*, Falc. and Cautl.—*Miocene*, Sewalik Hills.—Fauna Ant. Siv. pl. 71, f. 1, 3; 6, 7; pl. 72, f. 1, 2; pl. 75, f. 9–12.
—— *Perimensis*, Falc. and Cautl.—*Miocene*, Perim Island.—Fauna Ant. Siv. pl. 76, f. 15 and 16.
—— *tichorhinus*, Cuvier.—*Pleistocene*, Chartham, Kent.—Owen, Brit. Foss. Mam. f. 125, 127; Somner's Chartham News, 1669.

Rhinoceros tichorhinus, Cuvier (upper molar).—*Cavern*, Kirkdale.—Owen, Brit. Foss. Mam. p. 335, f. 125.

—— *tichorhinus*, Cuvier (lower molar).—*Pleistocene*, Regent's Canal, London.—*Op. cit.* p. 337, f. 127.

—— *leptorhinus*, Cuvier.—*Pliocene*, Walton and Clacton, Essex.—*Op. cit.* p. 356, f. 129, 131–135, 138–141.

Lophiodon or *Palæotherium* (phalanx).—*Eocene*, Isle of Wight.—Owen, Brit. Foss. Mam. p. 309, f. 106.

Paloplotherium annectens, Owen (cranium and lower jaw).—*M. Eocene*, Hordwell, Hants.—Quart. Journ. Geol. Soc. 1848, vol. iv. pl. 3, f. 1–3.

Hippotherium Antelopinum, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna, Siv. pl. 82, f. 13–17; pl. 84, f. 5–7, 9–12; pl. 85, f. 9–16, 18.

Equus Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna, Ant. Siv. pl. 81, f. 1–4; pl. 82, f. 1–3, 5, 6; pl. 84, f. 1–4; pl. 85, f. 1, 3, 5, 6, 8.

—— *Namadicus*, Falc. and Cautl.—*Miocene*, *Pliocene*, Sewalik Hills?, Nerbudda.—Fauna, Ant. Siv. pl. 81, f. 5–7; pl. 82, f. 7, 8.

—— *palæonus*, Falc. and Cautl.—*Pliocene*, Nerbudda.—Fauna Ant. Siv. pl. 82, f. 9–11.

—— sp.—*Pliocene ?*, from the Irawaddi.—Fauna, Ant. Siv. pl. 82, f. 12.

—— sp.—*Pliocene*, Nerbudda, Nelee Pass.—Fauna, Ant. Siv. pl. 84, f. 13, 14; pl. 84, f. 15, 17–19.

Coryphodon eocænus, Owen.—*Eocene*, Essex coast.—Brit. Foss. Mam. p. 299, f. 103; f. 4, 107.

Tapirus priscus, Kaup.—*Red Crag*, Woodbridge, Suffolk.—Owen, Journ. Geol. Soc. 1856, vol. xii. p. 233, f. 9.

Nesodon ovinus, Owen.—*Pleistocene*, S. W. coast of Patagonia.—Phil. Trans. 1853, p. 291, pl. 15, 16.

Hippopotamus (Hexaprotodon) Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 60, f. 1–3; pl. 61, f. 1, 2, 4–11; pl. 62, f. 2–8, 10; pl. 63–66.

—— *(Hexaprotodon) Iravaticus*, Falc. and Cautl.—*Pliocene ?*, Irawaddi River, Central India.—Fauna, Ant. Siv. pl. 57, f. 10.

—— *(Hexaprotodon) Namadicus*, Falc. and Cautl.—*Pliocene*, Nerbudda River, Central India.—Fauna, Ant. Siv. pl. 58, f. 1–3.

—— *(Tetraprotodon) palæindicus*, Falc. and Cautl.—*Pliocene*, Nerbudda River, Central India.—Fauna Ant. Siv. pl. 57, f. 1–4, 6–9; pl. 58, f. 4–10; pl. 62, f. 11, 12.

Hyopotamus Vectianus, Owen.—*Eocene*, Isle of Wight.—Quart. Journ. Geol. Soc. vol. iv. p. 102, pl. 8, f. 1–5.

Sus (Hippohyus) Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 70, f. 1; pl. 71, f. 1–4.

—— *giganteus*, Falc. and Cautl.—*Miocene*, *Pliocene*, Sewalik Hills, Nerbudda River.—Fauna Ant. Siv. pl. 69, f. 1, 3; pl. 70, f. 4–7; pl. 71, f. 12, 15–19; pl. 72, f. 8.

—— *Hysudricus*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 70, f. 2, 3; pl. 71, f. 5–11.

Microchærus erinaceus, Wood.—*M. Eocene*, Hordwell, Hants.—Charlesworth, Geol. Journ. pl. 2, f. 1.

Chalicotherium Sivalense, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 80, f. 2–4.

Dicobune ovina, Owen (lower jaw).—*U. Eocene*, Isle of Wight.—Quart. Journ. Geol. Soc. 1857, vol. xiii. p. 25, pl. 8.

Cainotherium commune, Brav.—*Miocene*, Allier, France.—Blainv. Ostéog. pl. 7, Pachyderma.

Merycopotamus dissimilis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 62, f. 15–18; pl. 67, f. 1–8; pl. 68, f. 1, 3–8, 11–15, 17, 18.

Didymodon Vauclusianum, Blake (portion of lower jaw).—*Eocene*, Vaucluse.—Geologist, 1863, Vol. XI. p. 8, pl. 2.

Cervus tarandus, Linn. (cranium).—*Cavern*, Berry Head, Devon.—Owen, Brit. Foss. Mam. p. 481, f. 198.

Camelus Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Asiatic Researches, 1836, vol. xix. p. 120, pl. 20, f. 3, 4, 6; pl. 21, f. 8, 11–13; Fauna Ant. Siv. pl. 86, f. 2–5; pl. 87, f. 1–11; pl. 88, f. 1–6; pl. 89, f. 1–14; pl. 90, f. 1–15.

Sivatherium giganteum, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Asiatic Researches, 1835, vol. xix. p. 1, pl. 1; Fauna Ant. Siv. pl. 91–2.

Bison priscus, Bojanus (cranium).—*Pleistocene*, Eschscholtz Bay.—Beechey, Voy. of 'Beagle,' 1831, vol. ii. p. 593, pl. 3.

—— *priscus*, Bojanus (metatarsal).—*Pleistocene*, Clacton, Essex.—Owen, Brit. Foss. Mam. p. 497, f. 207.

Bos frontosus, Nielson (cranium).—*Pleistocene*, Bawdsey Bog, Suffolk.—Mackie, Geologist, 1862, Vol. V. pl. 15.

—— *primigenius*, Bojanus (cranium).—*Pleistocene*, Atholl, Perthshire.—Owen, Brit. Foss. Mam. p. 498, f. 208, 209.

Bubalus moschatus, Owen (cranium).—*Pleistocene*, Maidenhead.—Quart. Journ. Geol. Soc. 1856, vol. xii. p. 127, f. 1–3.

Balanodon physaloides, Owen.—*Red Crag*, Felixstow.—Brit. Foss. Mam. p. 536, f. 219, 226, 227.

Phascolotherium Bucklandi, Brod. sp. (lower jaw).—*Great Oolite*, Stonesfield.—Owen, Trans. Geol. Soc. vol. vi. p. 58, pl. 6, f. 2; Foss. Mam. p. 61, f. 20; *Didelphys*, Zool. Journ. vol. iii. p. 408, pl. 11; Buckland, Bridgw. Treat. pl. 2, f. A.

Thylacoleo carnifex, Owen.—Phil. Trans. 1859, pl. 11, f. 1; pl. 13, f. 1, 6–8; Owen, Palæontology, 2nd edit. 1861, p. 432, f. 173.

Diprotodon Australis, Owen.—*Pleistocene?*, Australia.—Palæontology, 2nd edit. 1861, p. 430, f. 171.

Nototherium Mitchelii, Owen.—*Pleistocene?*, Australia.—Quart. Journ. Geol. Soc. 1859, vol. xv. p. 176, pl. 9, f. 1, 2, 4, 5.

II. BIRDS.

Halcyornis toliapicus, König, sp.—*Eocene*, Sheppey.—Owen, Brit. Foss. Mam. and Birds, p. 554, f. 234, 235; *Larus*, König, Icones Foss. Sect. 1825, f. 193.

Archæopteryx macrura, Owen.—*Lithographic stone* (*U. Oolite*), Solenhofen, Bavaria.—Phil. Trans. 1863, p. 33, pl. 1, 3, f. 1; pl. 4, f. 1, 7, 8; Woodward, Intellectual Observer, 1862, vol. ii. p. 313; Mackie, Geologist, 1863, Vol. VI. p. 1, pl. 1.

Dinornis giganteus, Owen.—*Modern deposits*, Middle Island, New Zealand.—Trans. Zool. Soc. 1856, vol. iv. p. 159, pl. 47, f. 2, 3; Paléontologie, p. 330, f. 111.

—— *elephantopus*, Owen (entire skeleton).—*Modern deposits*, Middle Island, New Zealand.—Trans. Zool. Soc. 1856, vol. iv. p. 149, pl. 43–47, f. 1; Paléontologie, p. 330, f. 111.

Eggs of Birds.—*Paludinen Kalk* (*U. Eocene?*), Wissenau, near Mayence.—Leonhard and Bronn, Jahrbuch, 1849, p. 69, pl. 3.

CORRESPONDENCE.

Ancient Climates.

Dear Sir,—The readers of the 'Geologist' must, I believe, have all been as gratified by the perusal of the late articles from your hand as I have been myself, suggesting, as they do, ideas out of the beaten track. Indeed' from the editorial remarks which have appeared in several of the recent numbers, I perceive that to turn aside from the footprints of the *Schools*, and to tread in the stranger paths that point towards discovery, is an idiosyncrasy of your mind.

But my object in addressing you is not to point out that which must be patent to all your readers, but rather to offer some remarks on the ideas which the articles referred to express. My remarks are principally made with reference to the note on "Ancient Climates."

Before I come to a consideration of your own more immediate views upon the subject, as contained in the latter part of the paper, perhaps I should explain my opinions as regards what you rightly term one of the enigmas of geology—the maintenance on the earth's surface of a high temperature.

Let us for a moment carry ourselves back in imagination to those early stages of the earth's existence to which science is unable to assign even a probable date, and endeavour to appreciate, in the mind's eye, some of the conditions under which it laboured, when, glowing hot, it was first projected from the anvil of nature into those regions of the illimitable which were destined to be the scene of its career. I say glowing hot, because, although you imply that there is some reason to doubt its ever having suffered any great degree of heat, I for one have never entertained any opinion but that such was its state at one period.

From the burning, seething mass arises a dark and dense atmosphere, of which carbon and carbonic acid formed the great ingredients, presenting as effectual a screen against the entrance of the sun's rays as it did to the escape of heat from the body of the planet it surrounded. Though the sun occupied its place as the centre, its attributes—light and heat—as far at least as our planet was concerned, were not experienced, "and darkness was upon the face of the deep."

Gradually the external surface of this cloud-mantle radiated its heat into space—a very slow process, and one that might have taken ages to get rid of five degrees of temperature—and allowed the large overplus of carbonic acid to be deposited in the forms of limestone and mineral coal. The earth was now no longer "without form," but void.

Let us suppose so long a time to have elapsed that already the fervid body of our globe has cooled down to a comparatively low temperature—the dense mantle that once shrouded her has partially dissipated itself, but a gloomy obscurity still hangs over her, calculated to hold heat in an eminent degree. Water appears next *as* water, that before formed an element of the atmosphere only; in short, the waters were divided from the waters. The "firmament," as the early historian describes it, was not the cerulean expanse we are accustomed to see, but one of cloud scenery, through which the struggling sunbeams can with difficulty penetrate earthwards, obedient to the mandate of the Creator, "LET THERE BE LIGHT." After the appearance of land from out the waters which had been precipitated over the entire surface, vegetation made its way; but was it at all like the vegetation of the present day? I am inclined to think not. The part in nature that the vegetable world was to play had not been called on; other scenes were taking place on the great stage from which the curtain had but just gone up; the *Deus ex machinâ* of creation had not come on, and the full strength of the company was not yet required. I conceive this early vegetation to have been of a very luxuriant, though, generally, of a *fruitless* character, making up in mass of leaf and limb what it lacked in flower and fruit. This the large proportion of carbonic still in the atmosphere, and the dampness of the air, together with its high temperature, was calculated to bring about and to foster in the greatest degree. In this manner our coal-beds might have been stored; for it is hardly possible to conceive their formation under circumstances such as now exist. I conceive, moreover, that such a growth as I have described would have been highly necessary, in order to make a vegetable mould to mix with, and assist in the disintegration of the inorganic soil that must at first have formed the surface of the ground.

But the world was not destined to be the scene of the life and death of vegetation merely; and everything tended but to that higher purpose. The cooling proceeds to a yet lower temperature; the large amount of vapour which before had shrouded the earth began to be deposited freely; the sky often exhibited its blue tint; and, generally, meteorological processes were more in accordance with what they are at the present time. Vegetation now was required for the food of animal life, and therefore the *sun-light*, as well as heat and carbon, was necessary for its higher development. I conceive that it was at this epoch the two great *lights* were created which were to rule the day and night; for, although the sun was doubtless present when the rest of the system was made, the little light that penetrated the earth was only sufficient to *distinguish* day from night.

It is not necessary that I should follow up step by step the gradual cooling down of the atmosphere till it reached its present average temperature, which point it arrived at when the state of the sky no longer permitted the retention of heat, but, on the other hand, offered no resistance to the entrance of the radiated heat from the sun. The earth then derived its heat from the sun alone; a supply that is continually being received and given off, so keeping up a proper balance over the whole globe.

These notes on ancient temperatures are merely thrown out as *suggestions*, and not as final results, the product of any close investigation into the subject; I therefore beg that they will be received as such.

I had intended to offer some remarks on the latter portion of the paper, "the grand physical operations" that you conceive to have been at work in bringing about changes in the condition of our planet, but I fear that I have already extended my note beyond prudent limits, and therefore will defer any further observations, and remain, Sir, faithfully yours,

HENRY C. CRISWICK.

Greenwich, February, 1864.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

ROYAL INSTITUTION.—*January* 29.—"On the Glacial Epoch." By Professor Frankland, F.R.S.—Amongst the circumstances that have profoundly influenced the present physical condition of our earth, the action of ancient glaciers upon a scale of almost inconceivable magnitude has been gradually but irresistibly forcing itself upon the notice of philosophers since their attention was first called to it by Venetz and Esmark. There are few elevated regions in any quarter of the globe which do not exhibit indubitable evidence of the characteristic grinding and polishing action of ice-masses, although at present, perhaps, they are scarcely streaked by the snows of winter. In our own country the researches of Buckland, and especially of Ramsay, have clearly shown that the Highlands of Scotland, the mountains of Wales and Cumberland, and the limestone crags of Yorkshire, abound in these *roches moutonnés*, which leave no doubt that the valleys of those mountain ranges were once filled with glaciers of dimensions unsurpassed, if even equalled, by those which at the present day stream down the sides of their gigantic Swiss rivals. Nor was this perpetual ice of a former age confined to localities where no such phenomenon is now seen, but numerous observations have established that the glaciers of the present age, existing in Switzerland, Norway, and elsewhere, are but the nearly dried-up streamlets of ancient ice-rivers of enormous size. These glaciers have eroded the Alpine valleys, of which they once held possession, have carved out the lochs and kyles of Scotland, as well as the grander fjords of Norway, and have contributed in a most essential manner to the present aspect of our mountain scenery. Ramsay and Tyndall have recently called attention to this action of ancient glaciers, and have contended, with considerable plausibility—the former that the lake basins, the latter that the valleys of the Alps, have been thus, in great part, scooped out. In no part of the world, perhaps, can the phenomena of the glacial epoch be more advantageously studied than in Norway, where the ice-scarred coasts and fjords are still fully exposed to the eye of the observer, side by side with the ocean, which furnished the crystalline material that formerly covered them. Two thousand miles of coast, from Christiania to the North Cape, afford almost uninterrupted evidence of the vast ice-operations which, during the epoch in question, moulded nearly every feature of this remarkable country. Starting from Christiania, the traveller cannot fail to remark the peculiar appearance of the gneiss and granite rocks composing the coast, as well as the innumerable islands, which, forming a great natural breakwater, protect the shore from the heavy seas rolling in from the Atlantic. These rocks, here rarely rising to the height of 800 or 900 feet, present nothing of that sharp and rugged outline which generally characterizes such formations. On the contrary, they are smoothed even to their summits, all their angles worn off, and every trace of boldness and asperity effaced. To the casual and uninstructed observer the action of the sea suggests itself as a sufficient cause of these appearances; but it does not require much scrutiny to be convinced that the ocean waves have had little to do with this smoothing and polishing of the coast, since it is the surfaces sloping towards the land that are most acted upon; whilst in some places, where the rock descends precipitously towards the sea, and is subject to the dash of the waves, it has been protected from the abrading action, and presents merely a weathered surface.

Rounding the promontory of the Naze and proceeding northward, the coast presents, with slight exceptions, the same general features until the Arctic circle is approached, when the character of the scenery rather suddenly changes. The rocky hills acquire the dignity of mountains, and tower up in rugged, sharp, and fantastic peaks, contrasting strongly with the rounded summits of the lower latitudes. But these arctic peaks owe their immunity from the abrading action of ice solely to their height; around their bases, and even high up their sides, the slow surges of the moving glacial sea have made their unmistakable marks, grinding, and even undercutting, them into most extraordinary forms, as fine instances of which may be mentioned the Seven Sisters, and Torghatten, with its singular tunnel, just south of the Arctic circle; the Horseman, standing on the circle; and the mountains of the Folden and Vestjords, north of it: the latter having been justly described by the Rev. R. Everest as resembling the jaws of an immense shark.*

* The speaker was greatly indebted to his friend B. F. Duppa, Esq., for beautiful

To account for the advent and subsequent disappearance of such vast masses of ice, various hypotheses have been propounded. It has been suggested that the temperature of space is not uniform, and that our solar system, in performing its proper motion among the stars, sometimes passes through regions of comparatively low temperature: according to this hypothesis, the glacial epoch occurred during the passage of our system through such a cold portion of space. Some have imagined that the heat emitted by the sun is subject to variation, and that the glacial epoch happened during what may be termed a cold solar period. Others, again, believe that a different distribution of land and water would render the climate of certain localities colder than it is at present, and would thus sufficiently account for the phenomena of the glacial epoch. Finally, Professor Kämtz considers that at the time of the glacial period the mountains were much higher than at present—Mont Blanc 20,000 feet for instance—the Secondary and Tertiary formations having been since eroded from their summits.

The two last assumptions are attended with formidable geological difficulties, especially when it is considered that the phenomena of the epoch in question extended over the entire surface of the globe; they have therefore never acquired more than a very partial acceptance. With regard to the two first-named hypotheses, my colleague, Professor Tyndall, has recently shown that they are founded upon an entirely erroneous conception of the conditions necessary to the phenomena sought to be explained. The formation of glaciers is a true process of distillation, requiring heat as much as cold for its due performance. The produce of a still would be diminished, not increased, by an absolute reduction of temperature. A greater differentiation of temperature is what is required to stimulate the operation into greater activity. Professor Tyndall does not suggest any cause for such exalted differentiation during the glacial epoch; but he proves conclusively that both hypotheses, besides being totally unsupported by cosmical facts, are not only incompetent to constitute such a cause, but also assume a condition of things which would cut off the glaciers at their source, by diminishing the evaporation upon which their existence essentially depends.

The speaker divided the great natural glacial apparatus into three parts—viz. the evaporator, the condenser, and the receiver. The part performed by the ocean as the evaporator is too obvious to need description. The two remaining portions of the apparatus, however, are generally confounded with each other. The mountains are in reality the receivers, or *icebearers*, and are only in a subordinate sense condensers. The true condenser is the dry air of the upper region of the atmosphere, which permits of the free radiation into space of the heat from aqueous vapour.*

All the hypotheses hitherto propounded having therefore failed, in the light of recent research, to account for the conditions which brought about the glacial epoch, the speaker felt less reluctance in advancing a new theory, which had gradually elaborated itself out of the impressions he had received during a recent visit to Norway. Any such theory must take cognizance of the following points in the history of the glacial epoch:—1st,

coloured drawings of these remarkable objects, taken from the sketches of Professor James D. Forbes and Mr. Mattieu Williams.

* This radiation from aqueous vapour was experimentally shown by causing a jet of dry steam to pass in front of, and at a distance of two feet from, a thermo-electric pile; the galvanometer connected with the latter promptly showed a large deflection for heat, proving that the pile was receiving radiant heat from the aqueous vapour. A jet of air heated in the same manner and projected in front of the pile produced no such effect.

that its effects were felt over the entire globe. 2nd, that it occurred at a geologically recent period. 3rd, that it was preceded by a period of indefinite duration, in which glacial action was either altogether wanting, or was at least comparatively insignificant. 4th, that during its continuance atmospheric precipitation was much greater, and the height of the snow-line considerably less than at present. 5th, that it was followed by a period extending to the present time, when glacial action became again insignificant.

All these conditions he believed to be the natural sequences of the gradual secular cooling of the surface of our globe. *The sole cause of the phenomena of the glacial epoch was a higher temperature of the ocean than that which obtains at present.*

He then examined the grounds upon which this hypothesis is based. Numerous observations of the augmentation of temperature, at increasing depths from the surface of the earth, no longer leave room for doubt that the vast mass of materials constituting the interior of our globe is at the present moment at a temperature far higher than that of the surface. If this be so, the conclusion is almost inevitable, that at earlier periods of the earth's history this high temperature must, at all events at depths comparatively little removed from the surface, have been still higher, and that consequently the temperature of the surface itself must in former ages have been much more influenced by the internal heat than is the case at the present day. Tracing thus back the thermal history of our earth, it is conceivable that the waters of the ocean once existed as aqueous vapour in our atmosphere,—a condition which it is imagined obtains at the present day in Jupiter, Venus, and other planets, whose superior size or closer proximity to the sun may be supposed to have retarded the refrigeration of their surfaces. From the period, therefore, when the cooling of the earth's crust permitted the ocean to assume the liquid condition, its waters have gradually cooled from the boiling-point down to the present temperature, whilst the land has also undergone a similar process of refrigeration. *It was during the later stages of this cooling operation that the glacial epoch occurred.* For this assumption, however, it is necessary to establish that the rate of cooling of the land and of the ocean surfaces was unequal, otherwise the more rapid evaporation of the ocean due to increased temperature would be more or less neutralized by the impaired efficiency of the proportionately warm icebearers. The speaker then proceeded to describe the results of his numerous experiments, which conclusively proved that, under the conditions contemplated, the land would cool more rapidly than the sea. This effect is brought about principally by two causes, viz. the great specific heat of water compared with granite and other rocks, and the comparative facility with which radiant heat escapes from granite through moist air. The amounts of heat associated with equal weights of water and granite are as 5 to 1 in favour of the former, or, if equal volumes be taken, the water requires to lose twice as much heat as the granite in order to cool through the same number of degrees: but it is in regard to the escape of radiant heat from their surfaces that the superior retention of warmth by the oceanic waters is most strongly marked. The readiness with which radiant heat escapes from equal surfaces of water and granite at the same temperature through perfectly dry air is nearly equal; but so soon as aqueous vapour is interposed in the path of these rays, the conditions become wonderfully altered; the escape of heat from both is interrupted, but its radiation from the water is retarded in by far the greatest degree. This extraordinary intranscalency of aqueous vapour to rays issuing from water has just been conclusively proved in the physical laboratory of this Institution by researches made by Professor Tyndall, and not yet published. The difference between granite and water arising from this cause becomes vastly augmented when it is considered that the icebearing surfaces occupy an elevated position above the level of the sea, consequently the mantle of aqueous vapour which their radiant heat had to penetrate must have been much more attenuated than the comparatively dense shell lying between them and the surface of the ocean. Thus the obscure rays of heat streamed into space from the icebearing surfaces with comparatively little interruption, whilst the radiation from the sea was as effectually retarded as if the latter had been protected with a thick envelope of non-conducting material.

Whether we take into consideration, therefore, the conductivity of water and granite, their specific heats, or, finally, the respective facilities with which they can, under the cosmical conditions contemplated, throw off their heat into space, we find everywhere a state of things tending much more to the conservation of the heat of the water than to the retention of that of the land; and this of course applies also, *mutatis mutandis*, to the retention of that heat which is received from solar radiation. The luminous heat-rays of the sun pass freely through aqueous vapour, and are absorbed by both granitic and oceanic surfaces, but, once absorbed, these rays issue forth again as obscure heat of two different qualities or rates of vibration. To use Tyndall's beautiful explanation of the phenomenon, the vibrations of the liquid water molecules are of such rapidity as can be best taken up and absorbed by the same molecules in the vaporous condition. But granite is a very complex substance, and fewer of the heat-oscillations of its atoms are in unison with those of aqueous vapour; hence the heat-vibrations of granite disturb the molecules of aqueous vapour in their passage through the atmosphere in a less degree, and consequently the granitic rays are less absorbed.

Thus, whilst the ocean retained a temperature considerably higher than at present, the icebearers had undergone a considerably greater refrigeration. The evaporation from the ocean would therefore, at the period contemplated, be greater than it is at present, whilst the capabilities of the icebearers, as such, would not be perceptibly less. Moreover, it is evident that, during the whole of the cooling period, the ocean must have been receiving heat from its floor, and thus have acted as a carrier of warmth from the comparatively profound portions of the earth's crust to the oceanic surface. It thus resembled a mass of water contained in an evaporating basin, placed over a very slow and gradually declining fire. Under such conditions its cooling was protracted through a vast period, allowing sufficient time, between a temperature inimical to animal life and the commencement of the glacial epoch, to permit of the development and decay of those forms of animal life which existed in the preglacial seas.

Temp. F.	Evaporation per minute in Calm.	Evaporation per minute in Breeze.	Evaporation per minute in High Wind.
	Grains.	Grains.	Grains.
85°	4·92	6·49	8·04
75°	3·65	4·68	5·72
65°	2·62	3·37	4·12
55°	1·90	2·43	2·98
45°	1·36	1·75	2·13
35°	·95	1·22	1·49

The rate of evaporation of water at different temperatures and under various circumstances was determined by Dalton, whose results are embodied in the foregoing table. The evaporation took place in each case from a circular surface six inches in diameter.

We have no sufficient data to calculate the present mean temperature of the ocean, but in lat. 69° 40′ off the coast of Norway, at noon on a remarkably hot summer's day, Professor Forbes found the temperature to be 46·5° Fahr. The assumption of 40° Fahr. as the mean temperature off the coast of Norway, would therefore probably be in excess of the truth. Now, taking the mean of Dalton's results obtained at 35° and 45°, and comparing it with the mean of his results at 55° and 65°, it will be seen that an increase of 20° in the temperature of the ocean off the coast of Norway would double the evaporation from a given surface. Such an increased evaporation, accompanied as it necessarily must be by a corresponding precipitation, would suffice to supply the higher portions of the land with that gigantic ice-burden which groaned down the mountain slopes during the glacial epoch.

But would not the increased oceanic temperature tend to augment the mean temperature of the atmosphere even at considerable elevations, and thus raise the snow-line and reduce the area of perpetual snow? In answering this question, the speaker showed that the limit of perpetual snow does not depend so much upon the mean temperature of the atmosphere at that particular elevation, as upon the amount of snow accumulating during the cold season. Under the equator, the mean temperature of the snow-line is 35° Fahr.; in the Alps and Pyrenees, about 45°; and in lat. 68°, in Norway, it is only 21°. Thus the mean temperature of the snow-line rises as we approach the equator, which means that the snow-line itself descends below its normal height, owing principally to augmented oceanic evaporation accompanied by increased atmospheric precipitation. The deluges of rain which fall within the tropics far surpass the rainfall in the temperate and frigid zones, and doubtless the fall of snow upon intertropical mountains is proportionately great. The important influence which the amount of precipitation exercises upon the lower limit of perpetual snow is beautifully exemplified at the fine waterfall of Tysse Strenger, near the head of the Hardanger Fjord, and was first noticed by Mr. M. Williams. The spray from this fall, being frozen in winter, covers the valley for nearly half a mile with a stratum of snow and ice, so thick as to defy the solar rays of summer to melt it; thus lowering the snow-line by more than 2000 feet. The speaker had also seen in the Sör Fjord, under similar abnormal conditions, a mass of snow lying, in the month of August last, within 10 feet of the level of the sea, although the normal snow-line is there at least 4500 feet above the sea-level. That the height of the snow-line is essentially dependent upon the amount of precipitation, and

Latitude.	Height of Snow-line in feet.		
	Coast.	Interior.	Difference.
60°	5,500	4,450	1,050
62°	5,200	4,150	1,050
64°	4,200	3,650	550
66°	3,700	3,250	450
68°	3,450	3,000	450
70°	3,350	2,900	450

not upon mean temperature, is evident from a comparison of its height on the coast and in the interior of the Scandinavian peninsula, as given by Forbes in the accompanying table, compiled partly from his own observations, and partly from those of Von Buch, Naumann, and others.

Thus the difference between the height of the snow-line near the coast, where, owing to the impact of the gulf-stream, the winter is mild but the atmospheric precipitation great, and in the interior, where the climate is severe but the air comparatively dry, amounts in some cases to as much as 1050 feet, or nearly one-fourth of the total height. Such is the depressing effect of greater precipitation as regards the limit of perpetual snow; nor must it be forgotten that copious precipitation is altogether incompatible with great summer-heat. The incessantly clouded sky cuts off the solar rays, and moderates the summer temperature. It is a trite observation, that a wet summer is always a cold one. The mean temperature of the land in contiguity with such extensive surfaces of snow could also not fail to be considerably reduced; for although the actual amount of heat in activity at the surface of the earth was greater during the glacial period than subsequently, yet the cold of winter became stored up in masses of falling snow, which in melting absorbed the heat of the succeeding summer, and thus reduced both the mean and summer temperature of the land, especially of such portions of it as were not situated greatly below the snow-line. The common notion, therefore, that the glacial epoch was a cold one, is correct, although heat, not cold, was the *cause* of that epoch. This apparent paradox, that heat should be the cause of cold, finds its parallel in the ice-making machines which were in operation at the last Great Exhibition. In those machines which produced from 2 to 12 tons of ice per ton of coal, the glacial produce was directly proportional to the amount of heat developed by the combustion of coal.

But it is evident that this lowering of the snow-line by increased oceanic temperature could only occur within certain limits; for, although the mean temperature of the snow-line might rise from 21°, its present position in Norway, to 35°, its height under the equator, and perhaps even still higher, without any elevation of the snow-line itself, yet a further rise of mean temperature, which would result from a continued augmentation of oceanic heat, could not fail to elevate the snow-line itself, and eventually to chase the last portions of snow even from the loftiest mountain peaks. A process the inverse of this has gone on in nature, leading gradually to the glacial epoch, and eventually to the present meteorological condition of our globe. Whilst the ocean maintained a high temperature, the snow-line floated above the summits, possibly even of the most lofty mountains; but with the reduction of oceanic temperature it gradually descended, enveloping peak after peak in a perennial mantle, until during the glacial epoch it attained its lowest depression, whence it again rose, owing to diminished evaporation, to its present position.

The speaker considered that, inasmuch as recent researches had rendered all previous hypotheses regarding the glacial epoch absolutely untenable, the one for which he now contended could not be said to come into antagonism with any other views. It also further commended itself by requiring the assumption of no natural convulsion or catastrophe, no vast or sudden upheavals or depressions, and no change in the thermal relations of our earth to the sun or to space. On the contrary, it insisted that the glacial epoch was normally and gradually evolved from a thermal condition of the interior of our globe, which could scarcely be said to be any longer the subject of controversy.

In conclusion, this hypothesis suggests the probability that the other bodies belonging to our solar system have either already passed through a similar epoch, or are destined still to encounter it. With the exception of the polar ice of Mars, we have hitherto obtained no certain glimpse into the thermal or meteorological condition of the planets; neither is the physical state of their surfaces accessible to our best telescopes. It is otherwise however with the moon, whose distance is not too great to prevent the visibility of comparatively minute details. A careful observation of the lunar surface for more than a year with a silvered-glass reflector of 7 inches' aperture and of good defining power, had created in the speaker's mind an impression that our satellite had, like its primary, also passed through a glacial epoch, and that several, at least, of the *valleys*, *rills*, and *streaks* of the lunar surface were not improbably due to former glacial action. Notwithstanding the excellent definition of modern telescopes, it could not be expected that other than the most gigantic of the characteristic details of an ancient glacier-bed would be rendered visible. Under favourable circumstances the terminal moraine of a glacier attains to enormous dimensions; and, consequently, of all the marks of a glacial valley, this would be the one most likely to be first perceived. Two such terminal moraines, one of them a double one, appeared to him to be traceable upon the moon's surface. The first was situated near the termination of that remarkable streak which commences near the base of Tycho, and passing under the south-eastern wall of Bullialdus, into the ring of which it appears to cut, is gradually lost after passing crater 216 (Lubinietzky). Exactly opposite the last crater, and extending nearly across the streak in question, are two ridges forming the arcs of circles, whose centres are not coincident, and whose external curvature is towards the north. Beyond the second ridge a talus slopes gradually down northwards to the general level of the lunar surface, the whole presenting an appearance reminding the observer of the concentric moraines of the Rhone glacier. These ridges are visible for the whole period during which that portion of the moon's surface is illuminated, but it is only about the third day after the first quarter and at the corresponding phase of the waning moon (when the sun's rays, falling nearly horizontally, throw the details of this part of the surface into strong relief) that these appearances suggest the explanation now offered.

The other ridge, answering to a terminal moraine, occurs at the northern extremity of that magnificent valley which runs past the eastern edge of Rheita. This ridge is nearly semicircular, and is considerably elevated, both above the northern termination of the valley and the general surface of the moon. It may be seen about four days after new and full moon, but the position of the observer, with regard to the lights and shadows, renders its appearance in the rays of the rising sun by far the most striking.

With regard to the probability of former glacial, or even aqueous, agency on the surface of the moon, difficulties of an apparently very formidable character present themselves. There is not only now no evidence whatever of the presence of water, in any one of its three forms, at the lunar surface; but, on the contrary, all seleniographic observations tend to prove its absence. Nevertheless, the idea of former aqueous agency in the moon is by no means new. It was entertained by Gruithuisen and others. But if water at one time existed on the surface of the moon, whither has it disappeared? If we assume, in accordance with the nebular hypothesis, that the portions of matter composing respectively the earth and the moon once possessed an equally elevated temperature, it almost necessarily follows that the moon, owing to the comparative smallness of its mass, would cool much more rapidly than the earth; for whilst the volume of the moon is only about $\frac{1}{49}$th, its surface is nearly $\frac{1}{13}$th that of the earth.

This cooling of the mass of the moon must, according to all analogy, have been attended with contraction, which can scarcely be conceived as occurring without the development of a cavernous structure in the interior. Much of this cavernous structure would doubtless communicate by means of fissures with the surface, and thus there would be provided an internal receptacle for the ocean, from the depths of which even the burning sun of the long lunar day would be totally unable to dislodge more than traces of aqueous vapour. A globe of wax was exhibited which had been cast under water; it was highly cellular, and the water had been forced into the hollow spaces, completely filling them. Assuming the solid mass of the moon to contract on cooling at the same rate as granite, its refrigeration through only 180° F. would create cellular space equal to nearly 14½ millions of cubic miles, which would be more than sufficient to engulf the whole of the lunar ocean, supposing it to bear the same proportion to the mass of the moon as our own ocean bears to that of the earth.

If such be the present condition of the moon, we can scarcely avoid the conclusion that a liquid ocean can only exist upon the surface of a planet so long as the latter retains a high internal temperature. The moon then becomes to us a prophetic picture of the ultimate fate which awaits our earth, when, deprived of an external ocean and of all but an annual rotation upon its axis,* it shall revolve round the sun an arid and lifeless wilderness,—one hemisphere exposed to the perpetual glare of a cloudless sun, the other shrouded in eternal night.

NOTES AND QUERIES.

Geology of Sharpness.—The following passages, from a paper by Mr. John Jones, of Gloucester, read before the Cotteswold Club, are interesting:—"The district to which we shall chiefly direct attention at present is that which lies between Sharpness Point and the Hock Crib, at Fretherne (the 'Scearp-Nesse,' 'Acute Promontory,' and the 'Hock Crib,' or 'curved lying-place'), comprising the 'New Grounds,' so called from their having been formed and reclaimed from the Severn at a very recent period. . . .

"Crossing the wooden bridge, over the sluice which allows the waste waters of the canal to escape, we approach the place at which the ferry-boat from Pyrton, on the opposite side, lands its passengers; the names of both being probably derived from the same Anglo-Saxon elements of Pertún, 'the dwelling on the pier,' and evidencing the antiquity of the ferry, the rights pertaining to which are still strictly enforced by the lessee. An interesting chapter in practical geology may be read by the initiated from this spot.

* Mayer has recently proved that the action of the tides tends to arrest the motion of the earth upon its axis. And although it has been proved that since the time of Hipparchus the length of the terrestrial day has not increased by the one-hundredth part of a second, yet this fact obviously leaves untouched the conclusion to which Mayer's reasoning leads.

"We stand nearly upon the summit of the protruded Silurian dome, represented in a coloured section, published in the first edition of Murchison's 'Silurian System,' and may find in abundance under our feet characteristic shells and corals of the Upper Ludlow beds, though much damaged by the action of the tidal waters. The colour of this rock differs so little from that of the Old Red Sandstone beds which once rested immediately upon it, and still flank it, that the precise point of contact is difficult to discover.

"Upon the opposite shore, full in our view, are the Old Red Sandstone rocks which form the upturned edges of the Forest of Dean coal-basin, the equivalents of the cornstones, and show at a glance, by the well-marked anticlinal lines of their strata, dipping from one point towards Lydney, and from another towards Gloucester, the wave-like character of the motion of the subjacent beds, by which their elevation, with that of the Silurian rock just mentioned, was effected, and their curvatures produced. The transverse section, showing how this last passes under the others, appears to us to be of equal interest to the published section, and we have here ventured to produce it, from such observations as the constantly-changing bed of the river has enabled us to make; remarking, that from the inaccessibility of the former, the Club would confer a boon upon its members by republishing it.

"Walking along under the cliff towards the Berkeley Arms Inn, from the seat in front of which the finest view of the district, to be seen from the river, may be obtained, we arrive at the mass of Old Red Sandstone, anticlinal to that over which we have just passed, upon which the house stands, although, from the amount of silt deposited within the last ten or twelve years, the point of junction is obscured; and crossing the road leading to the pier, we come at once to the Lias beds, which form the well-known Purton section, reposing unconformably upon the same. Some forty years since, the principal channel ran under this cliff; but, from the operation of the breakwater commenced by the late Earl Fitzhardinge, land is rapidly forming here, and the current has been diverted to the Forest of Dean side. The alluvial deposit behind the breakwater, in the direction of our course, from its yet unstable character, renders it difficult to trace the Liassic beds from their immediate line of contact with the Devonian; but at the distance of about half a mile from the inn they become accessible. . . .

"Few scenes can more vividly impress themselves upon the mind of a young geologist than that which presents itself here after a fall of the rock, and its exposure for a few weeks to the tidal and atmospheric action. The beach is sometimes strewn with fossils in the finest possible condition, more especially as regards Gryphites, which are found of every type conceivable within the limits of one species; and that one only exists here, the writer has endeavoured to prove in a former paper, now forming a part of the Transactions of the Cotteswold Naturalists' Club. . . . (See notice in a former volume of the 'Geologist.')

"We have now arrived at the end of the cliff near the second breakwater. Higher up the vale of Gloucester, it is difficult to obtain a clear idea of the correlation of the vast beds of gravel composed of the detritus of the Liassic and Oolitic beds of the neighbouring hills, containing elephant and hippopotamous remains, occasional chalk-flints, etc., with what is popularly known as the *Northern* Drift (but to which appellation we conceive that there are substantial reasons for objecting). Be that as it may, the order of superposition is well shown in a small excavation within a few yards of the breakwater upon the edge of the cliff, where a bed of the gravel above-mentioned has been worked to a small extent.

"Upon the gravel rest two or three feet of vegetable soil, over which is strewn another bed of similar gravel, an inch or two only in thickness, and over all, under the existing herbage, the quartzose and red sandstone pebbles of the (so-called) Northern Drift. Taking our stand at this point, and scanning the vale with the eye of a geologist, we may readily trace the sequence of all the deposits of which the elements of the landscape around us consist. We cannot doubt that the Lias upon which we stand once stretched across what is now the channel of the Severn, and rested upon the Red Sandstone, as corresponding beds do at present on the opposite shore at Awre, near Poulton Court. Looking directly up the river, we may see distinctly, with the aid of a glass, the same bed stretching away in a corresponding direction at the Hock Crib, and we know that a few miles beyond this lies Westbury Cliff, where the lowest beds of the Lias rest upon the New Red marls; and these being at Flaxley, unconformably placed against the Upper Silurian rock, thrown up near Sir Martin Crawley's schools, enable us to judge at what period the great disturbance of the Protozoic formations in this neighbourhood took place.

"All these, from the Mayhill Sandstone to the upper beds of the Carboniferous system, had been placidly deposited in their due order in the depths of a vast sea.

"The section of the Forest Coal-field, in any direction shown upon the maps of the Geological Survey, indicates no relative disturbance of its component strata prior to that effected by the turning-up of its edges by the protrusion of older rocks, which form the tracts which separate it from the neighbouring coal-fields of Bristol and Glamorgan, the central portion remaining comparatively undisturbed. The relations of the Secondary to the Protozoic and eruptive rocks of the district are everywhere the same, and the line of unconformity between them may be traced from the trap boss at Tortworth, behind us, on the S.E., to the flanks of the Malvern range, before us, on the N.W. Wherever first or last exerted, we know that the cosmic force by which that great Sienitic mass was abruptly uplifted produced the contortions of the Silurian rocks around it, and the undulations of those before us and under our feet; passing hence, still upheaving Silurian strata through those of the Devonian age, and penetrating these again at Tortworth with a mass of trap, it subsides from this point under the Bristol coal-field, to produce effects analagous to those already described around and beyond it. It is not our object to trace further the development of this force and its consequences, but to bring more prominently forward than they have hitherto been brought in the Transactions of the Club, those geological features, easily accessible at many points in this country, by which we ascertain, approximatively, the period at which these commotions, to which we at present owe the diversity of its soil, and scenery, and access to its mineral wealth, took place. In and around the Forest we have precipitous escarpments of Carboniferous limestone and shales, with those of older rocks, in such position as to prove how great must have been the extent of their detritus, carried away we know not whither. As the ancient detritic material of the lowest and most compact strata—which would necessarily be the most recent, and the last exposed to aqueous action—has left no trace of its existence here, we may reasonably expect to discover any débris of the higher strata which once reposed upon these.

"We have no traces in the Forest area, for example, of the Magnesian Limestone and its associated beds, which in other parts of England, and upon the Continent, follow in regular series those of the Carboniferous system; yet we find at Bristol a Magnesian conglomerate, with the remains of undoubted Permian reptiles, and as we cannot believe, from the sharp angles of the rock-fragments of which it is composed, that they have travelled any considerable distance, we must necessarily suppose that the formation, of which it is the representative, *was* to some extent developed here.

"We have seen the upper beds of the New Red Sandstone deposited unconformably against the upthrown Silurian and the Old Red, at Flaxley and elsewhere; the Lias against the Old Red Sandstone, as here; and upon Silurian strata, as near Eastwood; Mr. Charles Moore has informed us that the fissures of the Carboniferous Limestone of his district contain Liassic fossils; and Mr. Etheredge has shown us a specimen of the same limestone bored by Lithophagidæ, at whose death their holes were filled up by then-forming Oolitic granules.

"Under these circumstances, as we are not acquainted with any group of strata intermediate to the Permian and Triassic formations, and as we do not find these in contact here, may we not reasonably infer that beds of Permian age *had* been deposited here in their due sequence, but having been swept away, either prior to, or in consequence of, their disruption by the disturbances indicated, when the deposition of the Triassic formation commenced, the forms of life which characterized them are here wanting, and the Mesozoic, which characterize the next vast epoch, have assumed their places? . . .

"A glance at the great Lias outlier of Robinswood Hill, looming up from the centre of the vale, reminds us that since the changes we have contemplated, others as remarkable have taken place; for we recollect that this must once have been conterminous and continuous with the Liassic slopes of the Cotteswolds, which form the background of the landscape, and flank it on the right. These, we know, are merely capped by beds of the Inferior Oolite, the detritus and fossils of which, mingled with those of the Lias, strew the valley from beyond Evesham to the quarry on the cliff which we have already visited, evidencing action to which they have been subjected, by which the deep combs and bays which indent them have been formed. The recent origin of the gravels is apparent from the remains of the great extinct pachyderms still found amongst them, and occasionally the shells of mollusca still existing around us.

"We have expressed some doubt as to the origin of the drift which overlies these gravels, to which the epithet 'Northern' has been expressly applied, because, the further we travel south-westward, the heavier and larger do we find the pebbles which constitute it become, and we may reasonably suppose that the smaller detritus wanders furthest from its parent rock. There may, indeed, have been an influx of similar material at the other end of the valley, but from its sparsely-scattered condition, and the minuteness of the fragments of which it is here composed, we feel rather disposed to ascribe to it a south-westerly than a northern origin. As compared with these drifts, the Severn Channel is of modern formation, for we see at this point that its bed is worn through them and their underlying gravels,—a circumstance which the want of coherence, and difference in the rock-materials here in juxtaposition, must have much favoured.

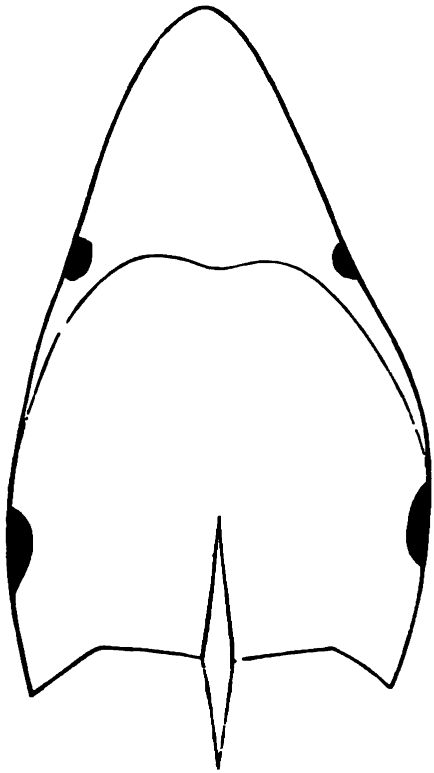
"Another feature of great interest in this district, to which our attention was first called by Mr. Clegram, is the existence of an extensive bed of peat, in which are found trunks and roots of trees, principally oak, in the ordinary state of what is popularly known as bog-oak. These may be best seen on the sides and in the bed of the watercourse called the Royal Drough, in the excavation of which they were first brought to light. They are accompanied by the catkins of hazel, and the leaves of waterflags and other plants, which show that they could not have been transported far from the place in which they grew. The thickness of the peat-bed is from four to five feet, and it is some feet below the level of high-water mark, covered by brick-earth, of the same character as that still deposited by the Severn, to the depth of ten or twelve feet, indicating that it must have been submerged to a sufficient depth for this accumulation to have been formed upon it, and subsequently uplifted to its present position. The same deposit is found on the opposite bank of the river, in the parish of Awre, and, as we are informed, on Walmer Common, in the parish of Westbury-on-Severn, at Whitminster, and in other places near Gloucester, from which its extent may be inferred. We are not aware that these facts have been previously noticed by other writers.

"The trees, when fairly uncovered in excavation, occur in great numbers, and very large 'stag horns' were found amongst them, some of which are said to have been taken to Berkeley Castle.

"An entire skull of the *Bos primigenius* was found in the Severn, not very far from Sharpness Point, near the spot where the fresh water of the Royal Drough, on the bank-cuttings of which these trees are now best seen, and which runs in places through the peat-bed, still keeping open a channel through the sands."

Restoration of Pteraspis.—Dear Sir,—In the May of last year I addressed a brief note to you, partly concerning the restoration of the test of Pteraspis, and which has been several times discussed by other correspondents and myself in the pages of your valuable magazine. Since then I have got from our Scottish rocks various additional fragments of Pteraspis, and a nearly complete specimen; and as it seems to cast light on some points already mooted and made matter of controversy, I trust you will allow it to be figured along with this communication.

I may say that I have both the specimen and its cast in the stone, and have attempted the outline of the test according to actual measurement. It will be observed by your readers, who take the trouble of looking back to previous numbers of the 'Geologist,' that this outline-figure closely resembles that contributed by Mr. Powrie to your February number of 1863. The specimen now before us differs from that of Mr. Powrie in size, although akin to each other in the relative proportions of their component parts. They differ however considerably in two other features which I am about to notice. First, the terminal edge on either side of the central prolongation or spine is not continuous in this new specimen, but is broken into segments; and, secondly, there is evidence of a protuberance, or it may be perforation (*a, a*), which I have not observed figured in any of the previous diagrammatical restorations of Pteraspis. I cannot certainly determine from my specimen whether it is perforation or protuberance, although I incline to think the former. I have no doubt however of what have been called the eye-orbits (*b, b*) being perforations, as the bony substance is exceedingly well preserved at that part of the test in the specimen before me, and the matrix is seen piercing the distinctly-defined orbital space. It has been thought by some that these anterior perforations are the nostrils, and if so, a conjecture may be hazarded that these posterior perforations are the eye-holes; but they may have served some other end in the economy of the organization of this curious old-world fish. This specimen exhibits very beautifully the characteristic internal structure of the plates as so well described by Professor Huxley. When looked at through a glass of feeble magnifying power, nothing can exceed the beauty of the external layer of bone, either in the regularity of the wave or in the grace of the curve of the ridges. It may be otherwise in the English Pteras-



pides, but no Scottish specimen, which I have seen, presents us with the cornua so fully developed in the kindred Cephalaspis.

I may add that I have had no further light thrown on the nature of the protection of the under side of the head of Pteraspis. I can only see, from the specimens I possess, that the plate of the upper side has a broad marginal rim or border turning downwards or inwards, but whether to lock into another plate I cannot affirm.

HUGH MITCHELL.

Craig, February 13, 1864.

FLINT IMPLEMENTS.—Sir Charles Lyell says, in his 'Antiquity of Man,' that flint-implements have occasionally been found on the beach between Herne Bay and the Reculvers, and that they are somewhat rare, since, so far as is known, not more than about twelve have been met with there. The most recent find is, I think, in my possession. In August, 1863, I spent some little time in attempting to discover the formation from whence these flints are derived, by, if possible, finding one *in situ*; failing in that, I determined to search the beach, and there saw one lying on its flat side on the shingle. It differs from those presented by Mr. Leech to the Jermyn Street Museum, which are from the same locality, in being smaller, much less pointed, and flatter at the base. Its length must have been 5 inches, and its greatest breadth 3¾ inches, exactly corresponding to the oval shape and size of the Amiens flint presented by Mr. Prestwich to the same museum. The edges are much fractured, either from use or water-rolling, probably both. GEO. J. STRONG.

Queen's Printing Office.

PHOSPHORUS IN NATURE.—This element is found in minute quantities almost everywhere in nature; it is an essential constituent of fertile soils, and of all living organisms. But people have been rather puzzled to account for the mountains of apatite (crystalline phosphate of lime) which have already been found in one or two parts of Europe, and which may exist in other quarters of the globe. We quote the explanation in Dr. Hofmann's Report of the Chemical Products and Processes in Section A of the International Exhibition:—"Large masses of phosphorus are, in the course of geological revolutions extending over vast periods of time, restored from the organic reigns of nature to the mineral kingdom by the slow process of fossilization, whereby vegetal tissues are gradually transformed into peat, lignite, and coal; and animal tissues are petrified into coprolites, which, in course of time, yield crystalline apatite." And then:—"After lying locked up and motionless in these forms for indefinite periods, phosphorus, by further geological movements, becomes again exposed to its natural solvents, water and carbonic acid, and is thus restored to active service in the organisms of plants and the lower animals, through which it passes, to complete the mighty cycle of its movements, into the blood and tissue of the human frame. While circulating thus, age after age, through the three kingdoms of nature, phosphorus is never for a moment free. It is throughout retained in combination with oxygen and with the earthy or alkaline metals, for which its attraction is intense."

TRADITIONS OF THE DELUGE AND OF THE UNITY OF ORIGIN OF MAN.—The subject of traditions was brought under discussion at a late meeting of the Ethnological Society, by a paper by the Rev. Mr. Farrar, who in general terms objected to the race-values, as well as the antiquity of traditions. One point is, however, in a geological aspect, I think, worthy of examination. I am under the impression that the tradition of a universal deluge, and of the descent of mankind from a single pair, is characteristic of the Caucasian races. Now the glacial era was seemingly inaugurated with unequalled copious rains, and passed away as a geological age in a multitude of debacles, seemingly from the melting of the vast quantities of snow and ice accumulated during that intensely cold period. The relics of man are found fossil in the deposits of at least the close of this period, and therefore primitive man would have been at least an eye-witness of the later debacles, if not of the inaugurating rains. To get out of the Gorilla-origin theory for a time, and to look justly at facts, we find the oldest fossil human skull—the Engis—belonging to the Caucasian or European type. If, then, the Caucasian peoples should be proved to be the only original preservers of the tradition of the deluge and single-pair parents of the human race, would it not be very confirmatory presumption in favour of the greater antiquity of European man, than of men of other species? We have nowhere got a fossil negro, and negroes have no traditions of these two popularly-believed events. If European man's antiquity extended to the debacles which closed the glacial age, there would be an original truth handed down to us in these legends; for although presented to us in an Asiatic aspect, there are race-characters in the Jews which should refer their primary origin to the European area; and although these glacial debacles produced no universal deluge, covering with its waters the tops of the highest mountains, yet local floods deluging so many and such various districts, would be so nearly coincident and contemporary in time, that their results would be practically, if not literally, universal.—S. J. Mackie.

Erratum.—P. 80, in communication from Mr. Pattison, *for* "Oltrungt" *read* "Oetrungt;" *for* "apparent Devonian" *read* "uppermost Devonian."

MISCELLANEOUS NOTICES.

The 'American Journal of Science' for January contains a translation of M. Perrey's Theory of Earthquakes, from his 'Propositions sur les Tremblements de Terre et les Volcans,' a continuation of Professor Dana's articles "On the Classification of Animals based on the Principle of Cephalization," the group of insects being taken up in the present number. There is also a short but most interesting note by the Professor, on some fossil insects from the Carboniferous formation in Illinois, accompanied by woodcut figures. These insect-remains were discovered by Mr. Bromson in the Carboniferous beds at Morris, Illinois. They occur in the flattened ironstone concretions of the beds, which also contain plant-remains and two or three species of Amphipod Crustaceans; one specimen is a Neuropter, closely like the Semblids, and especially the Chauliodes. The other specimen figured is also a Neuropter; it is a mutilated anterior wing, the neuration approximating to that of the genus Hemerobius. There is also an able paper on the "Density Rotation and Relative Age of the Planets," by Professor Henrichs, of the Iowa State University. The other articles are "On Tephroite," by Mr. Geo. J. Brush. Amongst the Notices—Unger's Scientific Results of a Tour in Greece and the Ionian Islands; Guyot's Physical Wall-Maps of the Continent; Professor Whitney on the Highest Mountains of the United States and of North America, and on the Survey of California; on the Constitution of Columbite, by H. Rose; Contributions to Palæontology, by Professor James Hall; Monograph of Fossil Estheria, by Professor Rupert Jones; Dana's 'Text-book of Geology;' Tract on Crystallography, designed for students of the University, by Mr. H. Miller, of Cambridge; Descriptions of Fossil Plants collected by Mr. Geo. Gibbs, Geologist to the U.S. North-west Boundary Commission, by Dr. J. S. Newberry.

THE GEOLOGIST.

APRIL 1864.

TWO OR THREE INCIDENTS IN A RAMBLE IN THE NORTH OF FRANCE.

By the Editor.

Having lived from infancy on the shores of the Channel, with the beautiful section of the Kentish coast constantly before my eyes, it is only natural that as a geologist I should take especial interest in the study of the Cretaceous Rocks, and being fully acquainted with their divisions, fossils, and details in my own district, I was desirous of instituting a comparison with those of the north of France, with which they are so intimately connected.

Narrow as are the straits which divide the two countries, considerable differences exist in the subdivisions of this formation as we proceed westward, and much is to be learnt from the study of the ancient condition of the various portions of the great oceanic basin of which both the strata of England and France alike are portions.

There was also another subject of much practical importance as well as scientific interest, which deserved to be studied on both coasts —the flint beaches. Constantly are they journeying from west to east; but where do they come from and whither do they go? From whence are they derived?

These were the objects for which, on the 3rd of September, 1854, I started for a month's ramble in the north of France. My health at the time was but very indifferent, and I was unequal to those exertions I should otherwise have made, and which were necessary to render the investigations and comparisons complete. Being, too, vacation-time, the Professors were generally absent from the towns, as were also most private families, and I thus lost much valuable assistance. Moreover, the antiquities and picturesque scenery of the Seine and the coast of Normandy proved so attractive, that my pencil was more employed than my hammer, and my sketch-book much fuller than my havresac. In truth, I idled by the way, and the work I went for never has been done. Some of the incidents on that trip, however, deserve a better fate than oblivion, and are worth the jotting down.

The period of my ramble was one of immense political importance to all Europe—to the world,—of the deepest and most anxious moment to the two countries, of whose profoundly remote geological history I was patiently endeavouring to read a solitary passage, spelling the words by petrified letters, and hoping to add another line to the popular translation of that wonderful book, in the study of which so many earnest and enthusiastic lives have been spent, and which to have helped to have read is the dearly prized and true reward of the scientific man's ambition.

Upon the soil I trod our forefathers had fought and bled, and the flower of the world's chivalry had met in sanguinary conflict on the very spots where now to me the hand of friendship was sincerely given, and as warmly returned. Every one's attention was turned to the East, where England and France had sent the bravest of their sons. Our Armada had sailed, and there was no one without some relative, some friend in that vast fleet, far more powerful than that which stands out so proudly emblazoned on the page of Spanish history, but which the winds of heaven and a little gallant band of Englishmen dispersed.

The first distracting incident of my voyage was the landing of Prince Albert at Boulogne; the next the great review of 60,000 men at Marquise.

The district of Boulogne is one of great interest, not only as the completing portion of the great circle of the elevation of the Wealden districts of Kent and Sussex, but that it has been at a more remote period the seat of convulsions which have brought the older rocks, even the Silurians, to the surface; and the fossils of all the beds from the Chalk to the Primary Schists and Limestones, may be gathered in that region of the little old island that there protrudes through the sea-deposits of the Secondary rocks. I have often been surprised that this wonderfully diversified and miniature area should not have been more worked.

Then came Abbeville and its gravels, and its fine old church, and its statue in the market-place; then the glorious cathedral of Amiens. Then a week's gaiety in Paris, and more than another week spent at Rouen and along the Seine, until a temporary stay at Frascati's gave me the opportunity of commencing but not finishing a study of the cliffs of Havre. The main cliff, or *falaise*, consists of the Lower or Grey Chalk, which there contains numerous beds of large chert nodules, in similar manner to the bands of flints in our Upper Chalk. The subdivisions of these beds I could not completely make out from top to bottom, but the notes I made are sufficiently accurate as far as they go, and for this reason are worth giving side by side with the subdivisions of the French geologist, M. Le Sœur, in 1843, it being borne in mind that the thicknesses of the strata, as given by me, are estimated by eyesight only, and *not* by actual measurement.

I. *Subdivisions of the Cretaceous and Wealden Formations recorded by M. Le Sœur at the Cliff under the Lighthouse at Cap La Hève*, 1843.

Terrain Diluvien :—

- Argile rouge ; sable fin ; silex pyromatique.

Craie Inférieure :—

- Craie chloritée grise ; lits et rognons de silex.
- Bandes de silex.
- Craie glauconeuse blanche.
- Bandes de silex.
- Lits et rognons de silex.
- Bandes de silex.
- Craie glauconeuse blanche et rognons de silex.
- Bandes de silex noir.
- Craie glauconeuse brune ; rognons de silex ; polypiers.
- (*Sources.*)
- Lits tendres endurcis de glauconie verte.
- Lits de marne bleue noire pyriteuse, avec lits de silex calcédoneux.
- Gros gravier ferrugineux.

Section at Cap La Hève (Mackie.)

		ft.	in.
	Double chert	0	8
1.	Chalk	0	10
	Ditto	1	4
2.	Chert	0	6
	Chalk	0	8
3.	Chert	0	6
	Chalk	1	0
	Parting.		
	Chalk	0	10
4.	Chert nodules, large and white	1	0
	Chalk		
5.	Chert nodules	0	8
	Chalk—weathers in.		
6.	Chalk	1	0
	Blue Parting.		
7.	Band of chert	0	10
8.	Greenish sandstone	0	9
9.	Greyish green-grained chert, wanting at places	0	6
10.	Greenish-yellow soft sandstone	0	6
11.	Band of cherty dark stone	0	9
12.	Seam of dark-grey stone	0	8
	Micaceous friable sandstone (soapy)	0	8

Sable micacé grossier, fin roux, blanc, ferrugineux.

Lits de fossiles.

Terrains Jurassiques :—

Lits alternes de marne et de calcaire marneux.

Lits alternes de marne calcaire et de calcaire hydraulique, argile hydraulique, argile à briques.

(*Huitres.*)

Argile à briques.

Lignite.

——————— Sea-level.

(*Huitres.*)

Lits de marnes.

Calcaire marneux.

Oolite.

Marne bleue.

II. ***Subdivisions of the same Formations as exposed in the Cliff beyond the Lighthouse, according to M. Le Sœur*, 1843.**

Terrain Diluvien :—

Sol superficiel.

Argile rouge; sable fin; silex pyromatique.

Sable Vert; Craie Inférieure :—

Craie chloritée grise; lits et rognons de silex.

Craie glauconeuse, blanche; lits et rognons de silex.

Bande de silex.

Craie glauconeuse brune.

(*Sources.*)

Lits tendres endurcis de glauconie verte.

Lits de marne bleue noire pyriteux, avec des lits de silex calcédoneux.

Gros gravier ferrugineux.

Formation Wealdienne :—

Sable micacé quartzeux fin blanc roux; veine de fer oxyde; brun noirâtre, avec nombreuses veines ferrugineuses.

———————Ligne de la mer.

Terrain Jurassique :—

Calcaire marneux.

		ft.	in.
13.	Bed of friable rock, hardening into stone	2	0
	With base of dark brown-grey rock with clay streaks	0	3
14.	Blue Parting	0	4
15.	Blue friable chalk, which scales off by weathering .	1	4
	Soft parting.		
16.	Band of dark-blue stone, with two broad bands of rubbly chert, looking like a single bed of rubbly rag	2	9
	Parting of dark-blue phosphatic chalk	0	8
17.	Grey friable rock	0	8
18.	Semi-cherty dark-blue rag-like stone	1	6
19.	Dark-blue parting, with molluskite	9	8
20.	Hard dark bluish-grey stone, and cherty stone, forming the top portion of a thick bed of dark-grey stone with green grains, enclosing green chert and molluskite	2	0
	Softer portion which dries white.		
21.	Cherty dark bluish-grey sandstone, with some chert (*Ventriculites* and *Choanites*)		
22.	Parting.		
23.	Black phosphatic bed, passing into—		
24.	Rubbly bed of soft friable rock	1	6
25.	Bed of soft friable sandstone	1	2
26.	Soft parting	0	4
27.	Bed of dark cherty-looking grey hard stone, (double?)	6	6
28.	Softening into Hassock (?) like Sandgate rock . .	6	6
	Soft parting	0	3

(Carried forward.)

		ft.	in.
Lower Greensand?	29. Dark stone-like hardened Sandgate-rock, with shells at base, and a few phosphatic nodules at top	0	6
	30. Black marly sands (like the Sandgate sand)	10	0
	31. Do. with phosphatic nodules	10	0
	32. Dark ferruginous grit, with concretions	8	0
	33. Pebble bed.		
	34. Greenish band	0	10
	And cindery Hassock (?) like Sandgate rock	4	0
Wld.?	35. Ferruginous sandstone.		
	36. White sand	10	
	37. Ferruginous sand.		

Section II. Equivalent to base of Section I. Taken nearer the Point of Cape (Mackie).

		ft.	in.
	31. Dark-blue bed with phosphatic nodules	10	0
	Dark ferruginous grit, with phosphatic nodules	8	0
	Grit	4	10
	Ferruginous sandstone.		
	Dark grit	10	0
	Pebble band.		
	35. Greenish band of cindery Hassock (?) like Sandgate rock.		
Wld.	36. White micaceous sand.		
	37. Ferruginous sands.		

Since, however, the days when I scrambled over the rough undercliff and up the craggy face of Cap La Hêve, the important attention which has been given to the quaternary deposits and the geological traces of the human race, has rendered one spot which excited then my interest still more interesting. It is a deposit of siliceous sand, containing recent species of shells, underlying a capping of ordinary angular flint drift-gravel.

Between Frascati's well-known hotel and baths, near the pier at Havre, and the commencement of the chalk cliffs of Cap La Hêve, the ground gradually rises into a low cliff of some twenty-five or thirty feet high, capped by a thick deposit of red clay, sand, and angular flints, exactly in appearance resembling the ordinary flint-drift that covers the chalk-hills of England. This flint-drift is seen on the coast in considerable thickness, covering the irregular surface of the chalk, and filling up numbers of those extraordinary cavities so familiar under the name of sand-pipes. It appears to have come down or over the pretty valley of St. Addresse, covering the subjacent rocks of every description to the present sea-level. Near the limekiln by Perrey's mill, the low cliff referred to commences, and consists of about 10 feet of red, flint-gravel drift; gradually becoming higher, until near the sea-baths it has acquired an elevation of 30 or 40 feet. It is here that at the base of the cliff we perceive the sand to contain several bands of the semi-fossilized shells of species still living in the district, and in great abundance in the sands of the opposite coast at Honfleur, Trouville, and Dives. As the cliff increases in height, the beds of sand become of course more visible, and near the commencement of the road to St. Addresse, a most excellent section is presented, the measurement and description of which is subjoined:

Section of Gravel and underlying Sand at St. Addresse.

	ft.	in.
Vegetable soil	3?	0
GRAVEL—Red, sandy, flint-gravel, drift . . . . 10? ft. and upwards?		
SAND DEPOSIT—Very friable, slightly adhesive, fine sand-rock, with lines of dark-green grains, and becoming slightly ferruginous at the base; crumbles in the hand	5	0
Band (more sandy than above) of shells of all ages and sizes, irregularly bedded, principally of *Cardium edule*	0	9
Parting of dark-green grains	0	1
Slightly adhesive sand-rock, as at top	0	3
Band of shells, irregularly bedded, principally of *Cardium edule*, *Mactra*, *Tellina*, becoming slightly ferruginous at the base	1	2
Parting with dark-green grains	0	3
Friable sand rock, containing band of great pebbles, some 4 in. square, with smaller pebbles and shells	0	4
Band of shells, irregularly bedded, *Cardium edule*, *Tellina*, etc.		
Band of small pebbles and comminuted shells	2	0
Resting on dark-blue argillaceous sand, intermixed at top with dark-grey sand	1	4
Grey argillaceous sand, semi-consolidated, containing at 28 in. from top a band of shells, *Cardium edule*, etc., with small univalves.		
Level of Beach.		

The shells found were principally those of the common cockle and Tellen, and these, though sometimes found in their normal position, were generally in the disorder and confusion so characteristic of littoral accumulations as to leave no doubt of the beds in question having formed at some former period a portion of the shore. The above-mentioned species of shells occurred in abundance, and no doubt a minute examination would add others to the list.

This portion of the section abuts against a great mass of *craie glauconeuse* and rubble, which almost seems to have parted the stream of flint-drift that surmounts the sand beds. The section from hence to the commencement of the cliffs of the Cape, consisting of a lofty sloping bank, is rendered extremely obscure by the vegetation which so luxuriantly covers it. There seems at places to be indications of sand, but whether the bed alluded to is continued, required more time and a more minute investigation than I had it in my power to bestow.

The existence of a bed of sand with recent shells below the flint-drift is a curious fact, if correct and I am not deceived by appearances. If correct, it should be of value in determining the comparatively modern origin of that great diluvial mass of angular flints, and the débris of the chalk, and of the Tertiaries, we find so extensively spread over the area of the Chalk.

If no error exists in my examination of the recent shell sand at Havre, the section there goes to show the recent origin of the "flint-drift," since not only the recent species of mollusks lived there, but even the configuration of the coast of Normandy must have had a near approximation to its present state before the drift gravel was deposited.

The undulating surface of the valley of the Seine must have approached nearly to its present line, although some differences either in the prevalent direction of the winds, or the outline of the shore, are required to account for the accumulation at that spot of so numerous a collection of shells, the mollusca and their débris being now on that side of the Seine, but sparingly distributed in consequence of the washing-away action of the boisterous seas, although such shells, as before stated, are abundant on the quieter shores of Honfleur, Trouville, and Dives.

If nothing more important be proved from this bed of sand, it must be admitted that an elevation of some feet has taken place in this district within a very restricted period. Of such an elevation we have also evidences on the English side of the Channel.

So like in mineral character is the flint-drift seen on the top of the cliffs of Cap La Hêve with that shown at the roadsides of the upper part of the valley of St. Addresse, that there seems no doubt of the continuity of the deposit over the shell-sand.

The mass of *craie* against which it abuts is not however *in situ*. The base of the cliffs of Cap La Hêve consists of marls, sands, and clays of the Gault, Greensand, Wealden? and Kimmeridge periods, by the rapid wearing away of which, the *craie glauconeuse* of which the upper portion of the cliff consists, is constantly falling or rather sliding down in enormous masses forming an extensive undercliff, as at Folkestone and the Isle of Wight in our own country. The direction of the dip shows that some of these beds would naturally be continued on the site of the "shell-sand," and this buttress of *craie* débris—for it consists of blocks and the regenerated material of several strata of the *craie glauconeuse*, as indicated by the mineral characters of the materials, the fossil shells, etc.—has slipped or been brought down from a higher level to its present position; and it is this which throws some doubt whether the flint-drift of our section may not have been brought down by landslips such as are now common at the Cape, and have been a portion of a former undercliff since cut into by the action of the sea. No fragments of shells, sand, or rock, indicating any amount of regeneration, are to be found in the "flint-drift," which consists entirely of ferruginous sand and angular pieces of flints, and which so far seems, allowing for local differences of mineralogical character, to be identical with the flint-drift so extensively distributed over this region. The next question to be determined, is how far back in geological history the species of shells found in the subjacent sand can be found to date their existence, because certainly the age of this shell-sand has to be mainly determined by its organisms, there being but little concurrent evidence as yet obtained from other sources than the mollusca found in the sand. The following are placed by Professor Forbes in his list of "species now living in British seas and found fossil in true glacial beds:"—*Mactra solida*, *Tellina solidula*, *Cardium edule*, *Nucula tenuis*, *Littorina littorea*; and *Mactra stultorum* is placed by the same author among the British species not found fossil in typical glacial beds, but occurring in contemporaneous Italian newer Pliocene strata.

The evidence therefore of the shells brings the age of this Havre sand between two limits, that of the Pleistocene on the one hand, and the Recent or Actual period on the other. The flint-drift, being superincumbent, must consequently take its place at a more recent stage than the sand within the same interval, if it be truly *in situ*.

The fossils of the recent shell-sand are well preserved, although extremely brittle, traces of colour being frequent, and the specimens of periwinkles, though not numerous, are hard, and but little changed in structure, excepting by the loss of albuminous matter. The portion of a tooth of *Elephas primigenius*, found on the shore in a mass of hardened sandy material near the termination of the valley of St. Addresse, and preserved in the cabinet of M. Flambard, indicates the existence and proximity of some Pleistocene deposit, the discovery of which would possibly throw much light on the position in time that our recent shell-sand ought to occupy. It would be highly interesting to determine the occurrence, and trace the connection of a freshwater marl or other deposit, containing bones of the Pleistocene mammalia, in this neighbourhood. In the drift exposed in the Cape cliff-section, there are evident signs of rude inclined stratification on the sides of the hollows and shorter sand-pipes of the chalk, and the inclination differs on either side, as we see to be the case with the ripples of sand which the strong current of a spring-tide makes on the seashore. We there see fragments of shells, or other comparatively large objects carried rapidly down the longer descending planes, and slowly up the sides of the steeper banks, and deposited beneath the crests of the waves. As the drifted shells render thus apparent to the eye the arrangement and disposition to which the grains of sand composing the bed of the shore are subjected, so by the disposition of the flints in the clays and sandbeds it seems to me we might interpret the directions and actions of the powerful flow that spread the drift over such extensive tracks of country. At least, whether we admit flood-action or not in the spread of the superficial deposits, a series of correct observations of such indications of the direction and arrangements of their contained pebbles and constituent materials would do much towards determining the direction of the current or force by which those materials were brought and deposited. The indications of drift-movement are generally, as far as I observed them, towards the north, but in some cases on the slopes of hills the course has evidently been southerly. The presence and form of the tongue of sand at St. Addresse seem to confirm the supposition that the flint-gravel overlying the "shell-sand" had a southerly tendency, which would be the case if it were continuous with the drift of St. Addresse and the high ground of Cap La Hêve. Further observations are, however, necessary to confirm this opinion.

The deposit of sand containing shells must have been originally very considerable, as the waste by the sea on this coast being very great, even on the harder rock of the cliffs, its action on such soft materials must have been highly destructive.

Since writing the above, I find in M. Passy's excellent description of the department of the Seine Inférieure, an account of this recent shell-sand, which that author considers to be a portion of the ancient embouchure of the Seine.

Passing from Havre westwards, I made collections of fossils at Honfleur, Dives, and all along the coast up to Caen, the quarries of which pour their rubble down the green wooded slopes of a lovely gorge into the river below,—the white city with its lofty houses and over-topping churches and cathedral, and the low Oolitic cliffs fringing the blue waters of the Channel in the distance, form an enchanting scene worthy of a longer pilgrimage than it takes to see.

From Caen I took the steamer back to Havre, and thence trudged along the shore by Fécamp and Dieppe to Boulogne. A sketch from my notebook at Etretât may well close this gossiping article. The needles and arches of our Isle of Wight are household words in the British geologist's mouth. So are the arches and needles of Etretât in every Frenchman's. Etretât was a fishing village. It was fast rising, when I was there, into a watering-place; it may boast by this time of handsome rows of marine residences, but it will not be more worthy of visiting than when it was as my pencil presents it to my readers in Plate IX.

ON THE OCCURRENCE OF ACANTHODES IN PALÆOZOIC ROCKS.

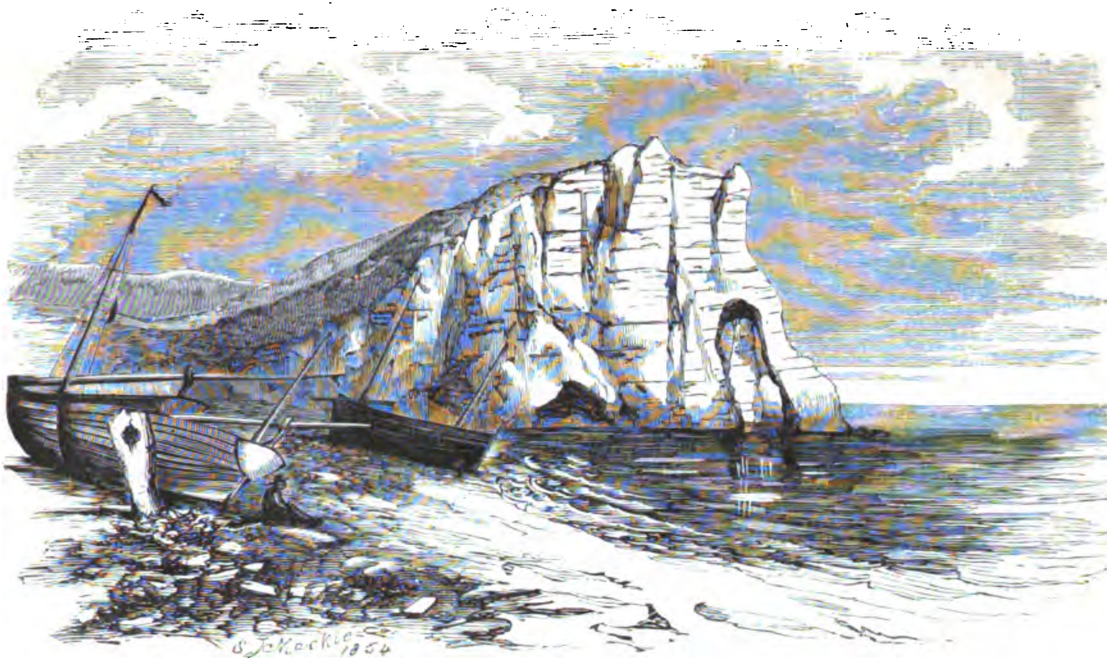
By Rev. Hugh Mitchell, M.A.

Whatever theory we may conceive or adopt respecting the origin of species, it is undeniable but that Acanthodes—a genus of fossil fishes—has maintained a noble struggle for life. Known to occur first of all in the Lower Devonian or Old Red Sandstone, it has been found also in the Middle Division of that great system, and again in the coal-measures, and finally disappears in the Lower Permian—the Roth-todt-liegende or Lower Dyas of German authors.

In the accompanying table we have endeavoured to put into accessible and readable shape the particulars of its occurrence, so far as known to us, among the rocks.

The Rocks.			The Species.	The Authorities.
Permian	Upper			
	Lower	*	Acanthodes gracilis, *Beyr*	Murchison, Journal of Geol. Soc. vol. xix. p. 303.
Carboniferous	Upper			
	Lower	*	A. Brouni, *Ag.*	Egerton, Geol. Surv. Dec. 10, p. 57.
		*	A. sulcatus, *Ag.*	Agassiz, P. F., p. 125.
Devonian	Upper			
	Middle	*	A. pusillus, *Ag.*	Agassiz, P. F., p. 301.
		*	A. Peachi, *Eg.*	Egerton, Geol. Surv. dec. 10, p. 57.
		*	A. coriaceus, *Eg.*	Egerton, Geol. Surv. dec. 10, p. 59.
	Lower	*	A. Mitchelli, *Eg.*	Egerton, Geol. Surv. dec. 10, p. 61.

We first detected the occurrence of Acanthodes in the Lower Devonian or Old Red Sandstone at Farnell, in the county of Forfar,



CHALK ARCH AND NEEDLE AT ETRÊTAT, NORTH COAST OF FRANCE.

Scotland, in the summer of the year 1857. From investigations since made, it now appears that an abundant flush of Acanthodian life ushered in the morning of the vast period embraced by the Old Red Sandstone. Along with the genus Acanthodes there occur also several other genera of the Acanthodian family, such as Climatius, Parescus, and some unnamed. The genera Climatius and Parescus were first founded upon and described by Agassiz, in his great work, from spines, but since the perfect forms have turned up in our northern rocks, it has been found necessary to remove them from among the Cestraciont Placoids into the Acanthodian family of the Ganoids, that is to say, provided we adhere to the classification of Agassiz. Other genera and species occurring with us remain to be described, and we are very much disposed to think that the spines figured from the Ludlow bone-bed in the Upper Silurian must be relegated to Acanthodian forms. Much as has been made of it, have we any evidence of the occurrence of Placoidal fishes in those rocks at all, except pieces of shagreen-looking skin? What if these, on closer scrutiny, turn out to be Crustacean and not Piscine remains? Would it not be worth the while of some of the earnest observers in that region to examine carefully those Ludlow beds, or especially their equivalents, where spines occur, for the complete forms? It was long thought that in our Scottish rocks of the Lower Devonian we had nothing but unattached spines of these fossil fishes.

It may be observed, in order to remove all doubt of the position here assigned to the beds of the Old Red Sandstone in which Acanthodes first occurs, that we have specimens on the same slabs with plates of the Pterygotus, and in the same stone with *Cephalaspis Lyellii*. It may be that other species of Acanthodes occur in our Lower, but it is certain that in the Middle beds of the Old Red, as they occur in Moray and Caithness, there is a fuller development of species. But in such a feature the genus would resemble many others in the geological muster-roll of being,—presenting us first with a weak dawn,—then culminating into meridian fulness, but again sinking into a slow decline and final extinction, yet still preserving throughout the career of their existence the characteristic traits of their generic life, the dying representative of the genus is not however a degraded form, but is as beautiful and as highly a developed creature as its first introduced ally. The outline of the body of the Acanthodes of the Lower Devonian Egerton describes as remarkably graceful, and Römer has given the specific appellation of *gracilis* to the Acanthodes of the Lower Permian,

It is certainly worthy of remark that the genus Acanthodes is persistent through such a lengthened period of geological existence; and from such a circumstance we are inclined to infer that as the details of the stony record are filled up, all gaps will disappear. We do not and cannot admit the truth of the theory of the transmutation of species, yet the course of creation has not proceeded by sudden bounds, but by a steady, calm advance. There is no evidence, so far as proof has been adduced, of the development of one good natural species into another; but there is evidence of a development of plan, and that development is but revealed to us in the occurrence, in these ancient life-periods, in succession of similar or kindred forms. Ever as the circumstances of their life are becoming alike, the species necessarily approach and resemble.

The history of Acanthodes, thus brought before us, almost warrants these conclusions:—First, there are no gaps, either in the succession of strata or in the course of creation, at least over lengthened periods, embracing it may be several so-called geological systems. A narrow horizon may indeed give the idea of wreck, but when the horizon of our observation is broadened, the chasms disappear. Secondly, there is evidence, at least in Acanthodes, there is no symptom of one true and good natural species developing into another, particularly not into a higher or advanced form. Thirdly, nor is there, as has been contended for by some writers, a degradation, either in size or in beauty, and other features of form, among species of the same genus, whose existence stretches over a long period. Fourthly. What however may be called digression or even retrogression of form appears in the development of the scheme of an Organized Creation. There is digression or departure from the type to put on some specific character towards an adaptation to some new circumstance in the life of the species; and again there is retrogression, a throwing off again of the specific or induced characteristic, and a return to the primitive or naked type. The mould in which the life is cast is not broken, but enlarged; yet after being enlarged, it is often again contracted ere the genus disappears in the onward current of the ages.

It is matter of regret with us now that when Egerton described in the decade of the Geological Survey the species of Acanthodes from the Lower Devonian, all our materials were not put into his hands. Distance is a sufficient excuse, but it is necessary to supplement his description by one or two remarks. The species occurs of a very small size. We have a specimen, scarce half an inch in length, a very minim of creation, but a perfect portrait in itself, with its every spine and every scale in their place. When well preserved, the scale appears to be perfectly smooth, and not ornamented in the least. And in many specimens there is a display of several small spines between the pectorals and the ventrals, as if the creature had an undercrop of rudimentary fins, which were attached to the spines, for the propulsion of its graceful and slim figure through the waters, and for its escape from its many enemies. The species occurs in our Old Red beds over almost the whole county of Forfar, and in the neighbouring county of Kincardine, and should be looked for in the equivalent beds of England.

ON THE FOSSIL FORAMINIFERA OF MALTA AND GOZO.

BY PROFESSOR T. RUPERT JONES, F.G.S.

In a former volume of the 'Geologist' there are notices of the geology of Malta and Gozo (vol. for 1860, pp. 198, 275, 421), from which it appears that the stratal groups forming these islands are, in downward succession,—

1. Upper Limestone; fossiliferous.
2. Soft sandy rock, consisting of yellow, green, and black sand in variable proportions, and containing many shells and echinoderms, chiefly as casts, and sharks' teeth.
3. Bluish marl, with sharks' teeth and other fossils, especially *Pecten Burdigalensis*.
4. Light-yellow calcareous freestone; the common building-stone of the islands, rich with echinoderms, and containing also nautilus, fish-remains, and other fossils: this comprises also a band of chocolate-coloured pebbles, with sharks' teeth.
5. Lower Limestone, white and hard; with *Scutella subrotunda*, fish-teeth, and a few other fossils.

These strata have been described by Captain Spratt, in the Geol. Soc. Proc., vol. iv. p. 225, etc., and their fossils determined and enumerated by Professor E. Forbes, *ib.*, p. 230, etc. Dr. Wright also gave a notice of the beds, and descriptions of several of their fossils, in a paper published by the Cotteswold Nat. Field-club, and in the Annals Nat. Hist., 2nd ser., vol. xv.; lastly, Dr. A. L. Adams and Dr. Wright communicated a paper on the Maltese Strata and Echinoderms to the Geological Society, in 1863.

Having lately received, from Captain F. W. Hutton and Dr. A. Leith Adams, some fine specimens of foraminifera from the Maltese beds, carefully labelled as to their respective strata, as well as some notes on the strata from the same friends, I am enabled to add something as to the distribution of the foraminifera.

Stratum No. 1, which, being largely composed of corallines (Nulliporæ, E. Forbes's List, *loc. cit.*), and destitute of corals, seems to have no title to its old name of "Coral-limestone," contains *Heterostegina depressa*, according to Dr. Adams and Captain Hutton; the latter informs me that this limestone is sometimes 230 feet thick, *Pecten Pandora* being one of its most abundant fossils.

Stratum No. 2, varying from 1 to 30 feet in thickness, is in many parts composed almost entirely of the little flat foraminifer that was formerly mistaken for a nummulite and a lenticulite, but is really *Heterostegina depressa*. The specimens of this bed (from Dingli, Malta, where it is 30 feet thick), with which I have been favoured by Captain Hutton, are dark-yellow friable shell-rock or limestone, consisting of Heterosteginæ massed together in every position, mixed with a few valves of Pecten, in a scanty granular calcareous matrix, with calcareous cement. Many of the grains are obscure foraminifera and débris of shells, etc. Mr. Parker has detected the following foraminifera in this matrix :—*Globigerina bulloides*, *Truncatulina lobatula*, *Planorbulina ammonoides* (Quart. Journ. Geol. Soc., vol. xvi. p. 300), and *Calcarina rarispina*.

Dr. Carpenter's allusion to this Heterostegina-rock as being found *in fissures* in Malta, appears to be incorrect (Introd. Foraminif. Ray Soc., 1862, p. 288).

In some places this bed contains a large quantity of green grains. These may prove, on examination by the microscope, to be casts of the cells of foraminifera, bryozoa, etc., as Bailey and Ehrenberg have shown other sands of silicate of iron really to be. Captain Spratt and Professor E. Forbes (*loc. cit.*) notice the occurrence of cetacean bones in this bed, and of oysters with the Heterostegina.

The bed No. 3, blue marl, about 100 feet thick, is not yet known to contain foraminifera; but should be examined with careful manipulation, as described in the 'Geologist,' vol. ii. p. 244.

No. 4, the freestone, consists of four or five divisions that run one into the other, lying in no regular order. The building-stone is that in which most of the Echinodermata are found. Captain Hutton and Dr. Adams state that the Heterostegina occurs in the freestone; the latter points out that it is much rarer than in No. 2, "and only in a drab or light-blue portion towards the upper parts of the bed." In Professor E. Forbes's list (*op. cit.* p. 230), Cristellaria and Nodosaria are said to occur in the upper division of this freestone; and within the last few days Captain Spratt has obligingly shown me the specimens referred to. They comprise *Nodosaria Raphanus*, *N. Raphanistrum*, *N. Radicula*, *Dentalina acicula*, *D. pauperata*, *Lingulina costata*, *Frondicularia annularis*, *Cristellaria calcar*, and *C. cassis*. No doubt numerous smaller forms will also be found; for these are the larger specimens of such a group of foraminifera as D'Orbigny has figured and described in his Foram. Foss. Bassin. Tert. de Vienne. Some of the specimens are yellowish, some are greyish, indicating at least two beds or seams that are rich with them.

No. 5 is the hard whitish limestone, also used for building; it is very variable in lithological character, Captain Hutton says, and more than 400 feet thick; he adds, that "it is at the top of this bed only that *Scutella subrotunda* is found." I find, by specimens that have been shown to me, that it also contains, in large abundance, *Operculina complanata* and *Orbitoides dispansus*.

The Operculinæ (which appear to be two subvarieties) occur gregariously in the upper part of the limestone, are associated with *Scutella subrotunda* and *Echinolampas scutiformis*, and "are very common at the fault at Migiar Selimi in Gozo, and at various points along the northern coast of Malta." (Dr. A. L. Adams.) A large hand-specimen that Captain Hutton has kindly given me, comes from Marsa Scala, Malta.

[We must remember that the so-called "*Lenticulites complanatus*" (an old name of *Operculina complanata*), of Professor Forbes in the Proc. Geol. Soc., *loc. cit.*, and of Dr. Wright in the Annals Nat. Hist., 2nd ser., vol. xv. p. 101, etc., is really the *Heterostegina depressa*, as the Maltese specimens in the Museum of the Geological Society show. See also Quart. Journ. Geol. Soc., vol. xvi. p. 300, *note*.]

Of the Orbitoides, Dr. Adams writes,—"They are characteristic of the point of transition between the Lower Limestone and the Calcareous Sandstone; indeed, I have seen them nowhere else. They are so abundant that whole masses of limestone seem to be entirely composed of them; properly speaking, they are fossils of the Lower Limestone, and are frequently associated with what you name *Operculina complanata*, which seems, as far as I can find out, also peculiar to the same situations." The only locality that Captain Hutton knows for the Orbitoides-rock "is just south of Fort Ricasoli."

Captain Hutton believes that he has detected foraminifera in thin slices of some of the hard white limestone (made up of more or less rolled calcareous débris) from St. George's Bay, Malta.

Obituary Notice.

THE REV. DR. ANDERSON,

OF NEWBURGH.

There is a solemn pleasure in paying a last tribute to those who have been our friends, and those we have respected. Death draws the dark veil between the living and the past away, and when one worker is taken away from the grand field in which we are labouring, the last act of kindliness to the departed those who are left can contribute is the record of the worth of the departed. Amongst the fossils of Dura Den, the Minister of Newburgh was a great and successful worker, as the fine slabs of fish in our museums, and some of the best plates in Agassiz's memorable 'Poissons Fossiles,' and in his 'Grès rouge d'Écosse' substantially testify. As a writer on geological subjects, Dr. Anderson will not take rank in highest eminence, but for the work he has done in his locality, he will stand in position with the best of our local-workers. The Edinburgh 'Evening Courant' of the 18th ult. gives a very nice notice of one that all who knew respected for his fine personal qualities.

The geological works published by Dr. Anderson were,—'On the Remains of Man in the Superficial Drift,' 'The Course of Creation,' 'The Geology of Fifeshire,' "The Geology of Scotland," in the Rev. Dr. Taylor's 'History of Scotland,' and 'Dura Den,' a monograph of that remarkable fossiliferous locality. Dr. Anderson, too, took a lively interest in the local affairs of his district, and in the antiquities of his parish. He was also the promoter of a motion in the General Assembly of 1860, for making the study of natural science compulsory on students of the Established Church. The testimony paid to his individual worth by the writer in the Edinburgh paper referred to, will find a ready response in the hearts of all who knew him.

CORRESPONDENCE.

Restoration of Pteraspis.

My dear Sir,—I should like, with your permission, to make a remark upon the Rev. Hugh Mitchell's interesting letter and sketch of Pteraspis. It seems to me that the specimen there sketched agrees with Professor Huxley's restoration (given in a former letter) in all particulars, saving the absence of lateral cornua, the form of the terminal angles, and the presence of the two large apertures which Mr. Mitchell has drawn in his letter. These differences are, I think, to be accounted for by the imperfect condition of Mr. Mitchell's specimen. I have seen some hundred specimens of Pteraspis with the lateral cornua and with no posterior apertures, but in every point agreeing with Professor Huxley's restoration. I have also seen some hundreds of specimens in a fragmentary condition, showing *no* cornua, no spine, no rostrum, and often showing apertures in the test, caused by fracture; but most palæontologists will, I think, agree with me in considering the more perfect specimens as indicating the true form of the shield of Pteraspis, and will attach no weight to the negative evidence of imperfect specimens. The restorations of Pteraspis given by Mr. Mitchell in May last, differ as much from the present one as it does from Professor Huxley's. In the former restoration there was no rostrum and no spine; but the discovery of fresh specimens has shown that the Scottish Pteraspides did possess spines and rostra like their English brethren. No doubt a little time will suffice to show that they also possessed lateral cornua and a form of the central disk, in nowise differing from that of the English specimens.

With regard to the under surface of the head of Pteraspis, even the great abundance of specimens in Herefordshire has afforded no evidence, save that of a negative character, and it seems to be a fair conclusion that it was unprotected; the mouth being placed as in the sturgeon, and perhaps of the same suctorial character. I may observe here, that in August last I obtained the first specimen of the scales of Pteraspis, from a quarry in Herefordshire. They are similar to those of the dorsal series of Cephalaspis, and are attached to a portion of the cephalic shield.*

Truly yours,
E. Ray Lankester.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Civil Engineers.—*January* 26.—"On the East Coast between the Thames and the Wash Estuaries." By Mr. J. B. Redman, C.E.—The object of this paper, like that of 1852 on the South Coast, was to describe the characteristics of a range of coast within certain limits, to trace the changes produced by constant natural causes, and the resultant influences on the various harbours; those of Harwich, Orford, Southwold, Yarmouth, Blakeney, Wells, and Brancaster being mainly dependent on such natural barriers as those described; as also their improvement, or deterioration, which

* A communication on the discovery of these scales has been addressed to the Geological Society.

in some instances, as at Yarmouth, by judiciously constructed works, material improvement was effected, and as at Orford, where no assistance was rendered, great changes occurred, or as at Harwich, where, from constant progressive change, it was difficult to speculate on the ultimate result of the continued operation of natural agencies, unchecked by works of a conservative character.

Geological Society.—*Jan.* 20.—1. "Observations on supposed Glacial Drift in the Labrador Peninsula, Western Canada, and on the South Branch of the Saskatchewan." By Professor H. Y. Hind, Trinity College, Toronto.—During an exploration of a part of the interior of the Labrador peninsula, in 1861, the author had an opportunity of observing the magnitude, distribution, and extraordinary number of the boulders on the flanks of the tableland of that area; and he commenced this paper with a detailed account of the results of his observations, referring also to the forced arrangement of blocks of limestone, shale, and Laurentian rocks in Boulder-clay at Toronto, and on the south branch of the Saskatchewan. Professor Hind then described briefly the Driftless Area, in Wisconsin, discovered by Prof. J. D. Whitney, and the conclusions to which that geologist has been led by the study of this district. He next adverted to the beaches and terraces about the great lakes, and considered their origin to be similar to that suggested by Mr. Jamieson for the Parallel Roads of Glen Roy. The formation of anchor-ice in the Gulf of St. Lawrence, and at the heads of rapids in the great river itself, was alluded to as one of the means by which river-beds may be excavated. The parallelism of escarpments in America, at great distances apart, and at elevations varying from 600 feet to 3000 feet above the sea, was next described, and their symmetrical arrangement suggested to be the result of glacial rivers undermining the soft strata of sedimentary rocks in advance of the glacial mass itself. These escarpments were also thought to represent different and closely-succeeding glacial epochs.

2. "Notes on the Drift-deposits of the Valley of the Severn, in the neighbourhood of Coalbrookdale and Bridgenorth." By Mr. George Maw.—The patches of drift occurring in the Valley of the Severn from about four miles below Bridgenorth up to Shrewsbury, including a north and south range of about twenty miles, have been carefully examined by the author, and were described in detail in this paper. Commencing with Strethill, a hill close to the entrance of Coalbrookdale, the author described the several beds which make up the drift-deposits of which it is composed, and gave a list of the rocks which he had found in them. In the same manner he described in succession the neighbouring districts in which the drift-deposits are exhibited, and gave a list of the fossils which had been found in the beds at the different localities. In conclusion, Mr. Maw put forward some hypotheses as to the period when the degradation of the older formations (the materials of which compose the Drift) took place, the manner in which the Drift was deposited, the extent of the submergence of England and Wales during the period of its deposition, and the influence of glaciers and glacier-action in its production.

February 3.—1. "On the Permian Rocks of the North-West of England, and their Extension into Scotland." By Sir R. I. Murchison and Prof. Harkness.—In this paper the authors propounded a new view of the composition of the Permian Group in the north-west of England; by rearrangement of the rocks involved in this change in classification, they were enabled to place the Permian strata of Great Britain in direct correlation with those of the Continent. This new feature in British classification is the assignment of a large amount of Red Sandstone in the north-western counties to the Permian period, and its removal from the New Red Sandstone, or Trias formation, to which it has hitherto been assigned in all geological maps. The authors showed that these Red Sandstones are closely and conformably united with the Magnesian Limestone or its equivalent, and form the natural upper limit of the Palæozoic deposits. They thus affirmed that a tripartite arrangement of the Permian rocks holds good in Westmoreland, Cumberland, and Lancashire, and that the three subdivisions are correlative with those formerly shown by Sir R. I. Murchison to exist in the Permian deposits of Germany and Russia; thus proving the inapplicability of the term Dyas to this group of rocks.

The difference, in lithological details, of the Permian rocks of the north-west of England from those on the opposite flank of the Pennine chain, was next adverted to; and it was observed that, with so vast a dissimilarity in their lithological development in England, we need not be surprised at finding still greater diversities in Germany and Russia.

The discovery, by Professor Harkness, in the central member of this siliceous group in Westmoreland, of numerous fossil plants identical with the species of the Kupfer Schiefer in Germany, and in the Marl-slate of the Magnesian Limestone of Durham, was given as a strong proof of the correctness of the author's conclusions.

The comparative scarcity of igneous rocks, and the evidence of powerful chemical action in the Permian strata of Britain, is contrasted with their abundance in deposits of that age in Germany; but proofs are nevertheless brought forward to show that the hæmatite of Cumberland and Lancashire was formed in the early accumulation of the Permian deposits.

In describing in detail the different members of the Permian group of the north-west of England, the authors define the downward and upward limit of the strata which have undergone dolomitization; for whilst certain bands of calcareous breccia (the "brockrum" of the natives), which occur in the central portion of the series, contain much magnesia, the lower breccias, composed of the same mountain-limestone fragments, have no trace of it; nor is it to be detected in the Upper Member, or St. Bees Sandstone.

A large collection of rocks and fossils from Victoria, Australia, presented to the Society by A. R. Selwyn, Esq., was exhibited.

February 19.—Annual General Meeting. Prof. A. C. Ramsay, F.R.S., President, in the chair.—The Secretary read the Reports of the Council of the Museum and Library Committee. The increase in the numbers of the Society, and the state of the Society's finances, were considered to be extremely satisfactory. The President announced the award of the Wollaston Gold Medal to Sir Roderick Impey Murchison, K.C.B., etc., for his many distinguished services to palæozoic geology, especially (1) for his great work entitled the 'Silurian System;' (2) for his important work 'On the Geology of Russia;' and (3) for his remarkable discovery of the true relations of all the rocks beneath the Old Red Sandstone that form the Highlands of Scotland; and, in handing the medal to the eminent recipient, he took occasion to review briefly the influence of these various labours on the progress of geological science. Sir Roderick Murchison, on receiving the medal, expressed his deep sense of the honour which had been done him by the Society, and which was enhanced by its being communicated to him through his friend and colleague Professor Ramsay. The President then stated that the balance of the proceeds of the Wollaston Donation Fund had been awarded to M. Deshayes, to assist him in his work on the Mollusca of the Paris Basin, and in testimony of the high esteem in which the Geological Society hold those labours, and placed it, together with a diploma to that effect, in the hands of the Foreign Secretary, for transmission to M. Deshayes. Dr. Falconer thanked the Society on behalf of his distinguished friend, and stated that he should have much pleasure in conveying to him this mark of the Society's approbation.

The President then proceeded to read his Anniversary Address, prefacing it with biographical notices of lately deceased Fellows of the Society, namely, Lucas Barrett, Esq., the Marquis of Lansdowne, John Taylor, Esq., Professor E. Mitscherlich, and S. P. Pratt, Esq.; he also gave a sketch of the chief labours of the late Rev. Stephen Hislop. In the address, the President discussed the breaks in succession of the British mesozoic strata; thus endeavouring to discover how far, and in what manner, the same kind of reasoning as that employed in the last address is applicable to Secondary formations. First, however, he examined the numerical relations which different classes of animals bore to one another in palæozoic times, comparing them with their development in Secondary epochs. The general conclusion arrived at was, that a long interval of time, often stratigraphically unrepresented, is an invariable accompaniment of a break in the succession of species; and the more special inference was that, in cases of superposition, in proportion as the species are more or less continuous,—that is to say, as the break in life is partial or complete, first in the species, but more importantly in the loss of old and the appearance of new genera, so was the interval of time shorter or longer that elapsed between the close of the lower and the commencement of the upper formation.

The ballot for the Council and officers was taken, and the following were duly elected for the ensuing year:—*President:* W. J. Hamilton, Esq., F.R.S. *Vice-Presidents:* R. A. C. Godwin-Austen, Esq., F.R.S.; Edward Meryon, M.D.; J. Carrick Moore, Esq., F.R.S.; Sir R. I. Murchison, K.C.B., F.R.S. *Secretaries:* P. Martin Duncan, M.B.; Warington W. Smyth, Esq., M.A., F.R.S. *Foreign Secretary:* Hugh Falconer, M.D., F.R.S. *Treasurer:* Joseph Prestwich, Esq., F.R.S. *Council:* John J. Bigsby, M.D.; Robert Chambers, Esq., F.R.S.E. & L.S.; P. Martin Duncan, M.B.; Robert Etheridge, Esq.; John Evans, Esq., F.S.A.; Rev. Robert Everest; Hugh Falconer, M.D., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; William John Hamilton, Esq., F.R.S.; J. Gwyn Jeffreys, Esq.; M. Auguste Laugel; Sir Charles Lyell, F.R.S. & L.S.; Robert Mallet, Esq., C.E., F.R.S.; Edward Meryon, M.D.; John Carrick Moore, Esq., F.R.S.; Professor John Morris; Sir R. I. Murchison, K.C.B., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Professor A. C. Ramsay, F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Alfred Tylor, Esq., F.L.S.; Rev. Thomas Wiltshire, M.A.; S. P. Woodward, Esq.

February 24.—1. "On further Discoveries of Flint Implements and Fossil Mammalia." By Mr. J. Wyatt, of Bedford.

The opening of a section at Summerhouse Hill gave the author an opportunity of ascertaining whether the gravels at that Lower Level exhibited any features different from those of the Upper Level at Biddenham. Although, as might have been expected, some of the species of mammals were found to be common to the two localities, yet that under notice furnished some species of mammals, as well as of shells, together with a few types of flint implements, differing from those met with at higher levels. Mr. Wyatt described the section at Summerhouse Hill in detail, showing that it tended to support Mr. Prestwich's opinions respecting the formation of gravel-beds; he also described the flint implements he had recently found, comparing them with known specimens from the Valley of the

Somme and elsewhere; and he stated that he was now enabled to add two new localities near Bedford—Summerhouse Hill and Honey Hill—to those already known as having furnished similar weapons.

2. "On some Recent Discoveries of Flint Implements in Drift Deposits in Hants and Wilts." By Mr. John Evans.

Flint implements having recently been found on the seashore, about midway between Southampton and Gosport, by Mr. James Brown, of Salisbury, and also at Fisherton, near Salisbury, by Dr. H. P. Blackmore, of that place,* the author visited these localities in company with Mr. Prestwich, and gave the results of his observations in this paper.

After describing the implements from near Southampton, and having shown that their condition is identical with that of the materials composing the gravel capping the adjacent cliff, Mr. Evans proceeded to review the evidence of the great antiquity of these remains, which rested mainly on the circumstance that these gravel-beds, like those of Reculver, are of fluviatile origin, although now abutting on the sea.

In like manner the author then described the Fisherton implements, and the gravel-pits from which they were obtained. The relation of the high-level gravels (in which the implements were found) to the lower-level gravels of the valley of the Avon was next discussed, and the geological features of the former deposits particularly described, lists of the fossils (including mammalia and land and freshwater shells) being also given. Mr. Evans came to the conclusion that the fossils bore evidence of the climate, at the time when they were deposited, having been more rigorous, at any rate in the winter, than it now is; and to this cause he attributed the comparatively greater excavating power of the early Postpliocene rivers.

Manchester Philosophical Society.—*January* 12, 1864.—The President, Mr. Binney, made some remarks on the Lancashire and Cheshire Drift. In the year 1841 he first attempted to class the drift-deposits found in the neighbourhood of Manchester, in a small paper with a map, which he prepared for the Statistical Society of Manchester. In that memoir he divided the foreign drift in the ascending order:—(1) Lower sand and gravel; (2) till; (3) upper sand and gravel; and he described the more modern deposits found in valleys; (4) as valley gravel. This order he adopted in a paper read before the Manchester Geological Society on the 22nd December, 1842, "Notes on the Lancashire and Cheshire Drift," and printed by that Society in their Proceedings of 1843. In that paper, in treating of the upper beds of sand and gravel, he says, "At Manchester, it (the higher drift) is composed of lower gravel, till, and sand and gravel; while at Heywood and Poynton, near the base of the Pennine chain, the beds of sand and gravel are parted by several beds of loam and clay." Again, in speaking of No. 3 deposit, he says, "The gently-rising lands of the two counties are generally composed of this deposit. It varies much both in its composition and thickness. Near the sea at Ormskirk, the till is sometimes found without it; but as you proceed to the east it makes its appearance, and gradually thickens until it attains its greatest thickness near the base of the Pennine chain: not only does it increase in thickness, but it becomes more complex, and contains beds of clay, marl, and loam of several yards in thickness. The country lying between Manchester, Bolton, Bury, Rochdale, Ashton, and Stockport, for the most part is upon it, and forms one great sandbank, which continues south into Cheshire." The same

* This discovery has been recorded already in the 'Geologist,' and we trust the acknowledgment will be duly made in the Quarterly Journal of the Society.

classification he adopted in two papers—one on the Drift of Manchester, and the other on the same deposits at Blackpool—printed in vols. viii. and x. of the Society's Memoirs, as well as in a paper printed in the Manchester Geological Society's Transactions for June, 1862.

Mr. Hull, in his communication, read at the last meeting of the Society, divided the higher drift deposits into (in descending order):—"(1) Upper Boulder Clay; (2) Middle Sand and Gravel; and (3) Lower Boulder Clay. The Nos. 2 and 3 had been described by the President as also a lower bed of sand and gravel, of whose existence he (Mr. Hull) had considerable doubts, and considered it as merely accidental." Now, in his (the President's) paper on the Drift of Manchester, eleven sections of wells and bores are given, and in ten of those the lower sand and gravel had been met with; thus showing that it can scarcely be considered as merely accidental, as Mr. Hull states. In many other sections since examined in Lancashire, this deposit has also been found under the till. With regard to the upper bed of boulder clay, to which the President had alluded, Mr. Hull considered it to be quite as important as the lower, both in thickness and area.

The old term "till" is as good as that of boulder clay, and as it has been long used there is not much use in changing it. During the last twenty years he had collected many facts, which he intended to publish when he had completed his collection, but these did not show one bed of clay or marl which could be called upper boulder clay, but several; in fact, there were numerous intercalations of it in the sand and gravel, one of which he had seen occurring at Kersall Moor, entirely surrounded by sand. To show the complexity of these deposits, and the difficulty of reducing them to two, he gave two sections, one near Hyde and the other at Outwood, where the following strata were met with:—

HYDE.

	Feet	in.
Clay	11	0
Quicksand	2	6
Strong marl	22	6
Quicksand	2	6
Loam with pebbles	12	6
Buck leaf marl	19	0
Dry sand	9	0
Quicksand and loam	6	0
Gravel	3	0
Loam	7	6
Gravel and sand	3	0
Clay and loam	15	6
Gravel and soft metal containing pebbles	10	0
Coal-measures		
	124	0

OUTWOOD.

	Feet	in.
Bog	11	0
Quicksand	53	3
Buck leaf marl	31	2
Red sand and gravel with a yard of clay in it	15	0
Toad-back marl	32	3
Gravel	3	0
Coal-measures		
	145	8

From the position of the Outwood section in a slight depression, and the higher grounds adjoining being capped with a bed of clay containing pebbles eight or ten feet in thickness, another deposit of clay should be placed on its top. Thus, in one case there are six beds of boulder clay, and in the other only three. These are two of the many instances which could be adduced, and suggest caution in attempting to classify these deposits without collecting and consulting numerous sections.

Manchester Geological Society.—*January* 19.—Mr. Dickinson, one of her Majesty's Inspectors of Mines, read a paper on "Modern and

Scriptural Geology." He had for many years endeavoured to reconcile the commonly-received geological theories with the Scriptural account of the creation of the world, and it was only after repeatedly returning to the subject that he had come to a simple view, which he believed was alike in accordance with observed facts and Scriptural record. He considered that the modern theories as to the formation of the earth involved many improbabilities. With the exception of pumice-stone, which might be produced by the local spontaneous combustion of some of the productions of the earth, occasioned by heat, friction, or chemical change, all things appeared to have originally been in a watery state. Even now rocks were so moist that a current of air driven through them at once became saturated; and the soft moist nature of rocks was further proved by the striations which were exhibited wherever the continuity of rocks had been dislocated. There were no remains of surfaces like that which covered now the earth; no beds of rivers; and as to the so-called denudation, rocks thousands of feet, nay, even miles in depth, would be wanting to account for the present alluvial deposit. Immense blocks of the denuded rocks would have remained. The pebbles and boulders were insufficient to account for what had disappeared; besides, a striking relationship existed between the pebbles and the underlying and adjacent strata. These pebbles, he believed, did not drift by glaciers, but were formed on the spot. The Scriptural account of the creation led him to suppose that water was the first element; that following the creation of light, which was the first day's work, expansion commenced; force had thus begun, and with the light apparently came chemical action, electricity, magnetism, heat, motion, and the like. Parts aggregated and repelled, until what we call the firmament was made. The waters then divided, part went above, and part went below, the latter being called the earth. Scripture also told them that every plant of the field and herb of the earth was in the earth before it grew, and this would account for fossil remains in whatever part of the structure of the earth they might be found. He considered that the earth was now in the same state as it existed after the dividing of the waters, and the striations on surface-rocks were the result of ordinary friction when in a soft state, when the waters divided. When the earth was cut into, there was a freshness about it which showed that it had seldom been disturbed in prehistoric times, and which refuted the notion that the world was any older than the period assigned by Scripture. The paper did not meet with a very flattering reception, but the author "knew of old what it was to express sentiments that were contrary to those commonly received as the fashion of the day."

Geological Society of Dublin.—*Jan.* 13.—Professor J. B. Jukes, F.R.S., in the chair. 1. "An Attempt to calculate the Duration of Time involved in Geological Epochs." By the Rev. Professor Haughton.—Geologists having got into the habit of speaking of long periods of time with extreme vagueness, he thought it a point of interest to consider how long animals could have existed on the globe. If we admit that the earth has cooled down from a gaseous condition to its present solid consistence, it is evident that organic beings could not have existed on the earth until it assumed some degree of solidity. Most geologists were acquainted with the ingenious proof, which we owe to Arago, that the earth has not cooled half a degree (Fahrenheit) since the time of Joseph. His proof is founded on the fact of Joseph's having received from Jacob, in the present sent to him to Egypt, some fruit which still grows in Palestine, and which will not bear a climate differing in any way from that of Palestine at the present day. Hence we see that the earth is only losing heat very slowly now. Professor Bischoff, of Bonn, made some experiments on the rate of cooling of basalt, and on these Professor Helmholtz had founded a calculation, by means of which he proved that the period which a globe of basalt of the size of the earth would take to cool from 2000° C. to 200° C. would be 350,000,000 of years. This calculation he would assume; and, as the extreme limits of temperature to which his reasoning would apply, he would take 122° F. and 77° F. The first is the temperature at which albumen coagulates, and therefore no animal could live at that temperature, as its blood would be coagulated. As the lower limit he would take the temperature of 77° F., which had been admitted to have been the probable temperature of these islands at the time of deposition of the London clay, Professor Heer, of Zurich, had lately expressed his opinion that the temperature of Switzerland during the Miocene epoch was between 67° and 72°, and that period was subsequent to the London clay. Assuming these limits, and the period above-named (350,000,000 years), as his data, he found that the earth, if it be supposed to be made of basalt, would require 1,280,000,000 years to cool through the required space. This reasoning was based on the well-known law of cooling of a heated body; and it was obvious to every one that the second period must be much longer than the first one, as the hotter a body is the faster it will cool. In this period we have space enough for the wildest phantasies of geologists. Professor Haughton did not conceive that changes of climate, produced by alteration in the relative positions of land and water, could account for the facts discovered by Sir L. M'Clintock about the fossils of the Arctic regions, nor did he now believe that the axis of the earth had changed its position.

2. "On the recent Discovery of Bones of the Polar Bear in Lough Gur, county Limerick; with Observations on their Comparison with Bones of the Cave Bear, in the collection of the Earl of Inniskillen." By Dr. Carte.—The locality whence the specimen was derived was a very famous one for such remains. The lake was remarkable for being supplied from springs, as there was no stream flowing into it; and as there were caves in the district, and throughout the whole country from that to Mitchelstown, it might perhaps be found that the lake was the site of an old flat-roofed cave, and that the animals whose bones were found there, and which belonged to the ordinary cave species, had lived in the district. They could not have been brought by drift, as the country was quite free from that deposit. It appears that the margin of the lake is studded with stone circles and other structures of antiquarian interest. The bones are found round an island in the lake, called Ganet Island, in shallow water. The whole lake is shallow, and has been much reduced in depth during the last few years by being drained by an artificial cut. The country people had raised several tons of bones, and sold them as manure. They consisted of a very heterogeneous assemblage of animals, such as deer, pigs, horses, cows, dogs, goats, sheep, etc., with stone celts, and fragments of human skulls; the latter of various ages, some very recent. Two species of bears had been found fossil in Ireland—viz. the cave bear (*Ursus spelæus*) and the brown bear (*Ursus arctos*), and that he believed that the subject of the present paper formed a third, viz. the *Ursus maritimus*.

Royal School of Mines.—Dr. Percy's Lectures on Chemical Geology.—Lecture II., *December* 12, 1863.—In the first lecture, the subject of silicon, one of the chief components of the solid crust of the earth, was considered. This silicon has only of late been carefully studied. It is certainly one of the most remarkable and important elements which we possess. It occurs, as will be remembered, in three distinct forms; the pulverulent state, or amorphous condition of silicon, which is extremely divided, and perfectly non-crystalline. It is in the form of a chocolate-brown powder, and it is indeed only recently that we have seen silicon in the crystallized state. We have it next in the graphitoidal state, or state resembling graphite. It occurs in the production of aluminium, or, at all events, it was first discovered in the making of aluminium by a particular process. It appears in the form of six-sided prisms, having a more or less metallic lustre and a dark bluish-black colour. Then we have what is termed the octahedral form of silicon. In many characteristics it is very similar to the graphitoidal. In colour, for example, one can hardly distinguish between the two. It crystallizes in the regular cubical system to which the regular octahedral belongs. Now, it is a curious thing that there is a remarkable analogy between silicon and carbon. Every chemist knows that there are very small chemical relations existing between the two; but with regard to the particular states in which the elements occur, we find an analogy obtaining. Thus, we have common charcoal, which is the amorphous or non-crystalline form of carbon; we have the amorphous or non-crystalline form of silicon; we have the graphitic form of carbon, exactly corresponding to the so-called graphitoidal form of silicon; lastly, we have the diamond, which is the crystalline form of carbon, and corresponds exactly to the octahedral form of silicon. In fact, silicon in this state has been called the silicon diamond.

How this silicon can be obtained belongs rather to purely chemical investigation. There is a compound, well known to chemists, called silico-fluoride of potassium or sodium. The transparent, colourless gas, consisting of fluorine and silicon, combines with potassium or sodium, forming a definite white salt—silico-fluoride of potassium or sodium. If we bring in contact with that salt some sodium or potassium, and also add a little common zinc, and heat the mixture, silicon is separated—displaced from its combination with fluorine by the sodium, and is immediately caught by the metallic zinc. The temperature should be such as to keep the zinc in a molten state. The silicon so separated dissolves in this molten zinc, and, on solidification, it separates more or less completely from the metallic mass in a definite, beautiful, distinct crystalline form, the silicon being dissolved through the mass of zinc. Common hydrochloric acid dissolves the zinc and leaves the silicon unacted upon. In this way these crystals can be obtained. Notwithstanding the powerful affinity of silicon for oxygen, and the great exercise of force which it requires to separate the oxygen from the silicon in the state in which they are combined in silica, yet, when the silicon is separated, it is astonishing how remarkably stable it is. It may be exposed to the air for an indefinite time without undergoing the least change. You may heat it, indeed, to a very high temperature, even with access of air, yet it shall not be oxidized. You may expose it to the action of various strong chemical reagents, and yet it shall undergo no change. It is extremely remarkable that a body which possesses such a strong affinity for oxygen, and requires the exercise of so much force to separate it from oxygen, should be so stable when separated as we find it to be. Exposed to a high temperature it fuses. A specimen of fused silicon was exhibited, furnished by Mr. Matthey, of Hatton Garden. This silicon is now playing a very important part in certain metallurgical operations. For instance, in the smelting of iron we find pig-iron produced in various furnaces containing a considerable portion of silicon, sometimes even as much as eight per cent., and frequently three or four per cent. The presence of it in iron modifies the properties of the latter considerably. It combines readily enough with copper. If we take a little copper or iron in a more or less divided state, say in the form of filings, and mix these filings with common sand (a compound of silicon and oxygen), and add an excess of charcoal, making a mixture of the three, and let the amount of charcoal and sand be such that, when we expose the mixture in a crucible to a high temperature sufficient to melt the copper or the iron, as the case may be, there should be sufficient of this mixture to retain the metal diffused through the mass, and then expose the mixture to a high temperature for a few hours—all the silica, under the conjoined influence of the carbon and the metal, is decomposed, the carbon laying hold of the oxygen, and escaping in the form of carbonic oxide, while the silicon is set free, combining with the metal. Common copper treated in this way—heated with sand and charcoal for a long time—undergoes a great change in its external appearance. It has no longer the red colour of copper, but has the appearance of bronze, which is a mixture of copper and tin. It is so like the bronze of which our guns are composed, that an inexperienced eye would not distinguish the one from the other when they are side by side. It is a very valuable alloy, so that you see that silicon may play a very important part even in the common arts of this country. To give another illustration of the fusion of silica. Platinum is a metal which requires a very high heat for its fusion. If we heat silicon in contact with platinum at a high temperature, no change will take place; but add a bit of charcoal, and repeat the experiment. The silica instantly becomes reduced under these conditions, and the silicon set free combines with the platinum, forming a very fusible compound.

The lecturer added a few more words concerning the proofs—the mineralogical or geological proofs—relating to the aqueous origin of crystallized silica, and they are very conclusive. Let us look at our mineralogical cabinets, and examine the specimens of quartz which we find therein. One was exhibited, a very small one, which, when examined minutely, was found to surround a mineral called hæmatite, consisting of peroxide of iron and water—a mineral which loses its water at a very low temperature. There it was, embedded in the quartz, clearly showing that the quartz never could have been exposed to a high temperature. Here is another mineral, carbonate of iron, embedded in the quartz, and the existence of this and the peroxide clearly shows that that quartz never could have been exposed to a high temperature, and supports the conclusion at which we have arrived touching its aqueous origin. Then we find incrustations which lead to the same conclusion.

With regard to amorphous silica, there is no doubt whatever about its aqueous origin. We can trace its origin in the clearest and most distinct way. In Iceland, for example, it is abundantly produced in the geysers. Here is a specimen which has been obtained from that source. Then, again, here is a specimen of granite from Iceland, on which is deposited a thin film of silica, having a pearly lustre. There is no one who will venture to say that that could have been thrown down on to the granite except by the agency of water. The specimens are very small in themselves, but, nevertheless, they speak very eloquently of the origin of silica, and tell an important tale, small as they are. Here is a very characteristic specimen showing the occurrence of crystalline quartz in two states on the very same portion of this mineral. One is the chalcedonic, or apparently non-crystalline. The lecturer used the word *apparently*, because the substance has been found to be composed of minute crystals. Close in contact with this is the other state, which is more or less non-crystalline; and then occurs a sort of granite deposit, which, seen under a magnifying glass of high power, is seen to consist of distinctly crystalline quartz. Amorphous silica exists in the shells of living infusoria; and it is found also in a siliceous concretion met with in the joints of the bamboo, known as tabasheer; it occurs also in petrified wood.

The lecturer next took up the subject of flint—a subject which has recently given rise to so much discussion. All were acquainted with the discovery of those wonderful nodules of flint in chalk, the formation of which is involved in doubt, notwithstanding that they are associated with the presence of sponge, and so on. There are, however, chemical difficulties which arise, and which will require much time to solve completely. When we take one of these dark flints, and expose it gradually to a temperature which we bring at last to a bright redness, it becomes very tender and fragile, and it would become especially fragile and perfectly opaque if heat were rapidly applied. It is in this way that the flints prepared for the use of potters are rendered fragile in the first instance, preparatory to grinding. Now when we examine specimens of flints we are frequently struck with an opaque white outer film, where the flint has lain in contact with chalk. This film or rind, if I may so call it, extends to a considerable depth. Well, what is it? Is there any chemical difference between this white rind and the inner dark portion of unchanged flint? This is a question which we have examined with some care, and by the aid of the most careful chemical analysis we are unable to detect any sensible difference between the two. The only conclusion therefore is, that the difference of appearance is owing to some molecular change; but how it is excited the lecturer was not prepared to say—whether by the slow operation of time, or whether, perhaps, by simple vibrations. It has often struck me, with regard to the flints which I have seen on the seashore, which have presented a white appearance, that possibly that appearance may have been caused by some operation of that kind; but upon that point he spoke with the greatest possible reserve. It is of very great importance to know exactly the effect of weathering upon the surface of flints, especially with regard to the great question now agitating the public mind concerning primeval man. Here is one of those wonderful things hewn out of flint by our rude forefathers, for the loan of which he was indebted to his friend Dr. Falconer. It presents a fracture at one end, which is very different from the contiguous portion; but at another portion there was observed to be the characteristic dark appearance of these ordinary flints. He had been examining this specimen, and upon the whole he thought it must have been long exposed, subject to some condition by which the surface has been changed. Then comes the question, whether it is possible to imitate these signs of age upon counterfeits of ancient flint implements. He thought a few experiments would very soon settle the point whether it is possible to give a surface very much resembling that which we find in these old weapons, by some chemical means.

With regard to the permeability of these flints by liquids, it is astonishing how pervious they are. If we immerse flint in sulphate of indigo and water, and keep it there some weeks, the indigo will penetrate to some depth.

It has been alleged, and it is a point of some importance, that silica may be volatilized, especially by the agency of steam. Every chemist knows that boracic acid, which is a fixed body, may, by the agency of steam, be vaporized to a considerable extent. A case of the volatilization of flint was recorded some years ago by Mr. Julius Jeffreys. It occurred in a potter's kiln in India. His statements have been repeated by many journalists, both British and foreign. It is important that we should examine the ground upon which he arrived at his conclusion. He allowed a large quantity of steam to pass through a potter's kiln, of which the temperature more than sufficed to melt pig-iron, and he afterwards observed round the opening of the kiln from which the steam escaped, several pounds of silica deposited in the form of snow. In commenting upon this statement, Berzelius, who accepted it, adduces as a parallel case the well-known volatility of boracic acid under the same conditions, and the fact observed by Gaudin concerning the volatilization of silica when melted before the oxy-hydrogen blowpipe. Now, the lecturer had examined all the original statements concerning this allegation, and he must say that the conclusion to which he had arrived is, that it is altogether unsatisfactory. There is no proof whatever, or, at all events, there is none advanced, that the deposit was silica at all. No analysis was made, and no man is justified, without the evidence furnished by analysis, in pronouncing definitely upon a point of this kind. Secondly, admitting that the substance called silica was really silica, there is no evidence to show that it was volatilized in the way described. We perfectly well know that in metallurgical operations a very large amount of finely-divided matter may be carried to a very long distance mechanically by gases or vapours floating over it. Volatilization is something different from the mechanical removal of the particles of a substance.

The subject next taken up was one of great interest—aluminium. This aluminium plays a most important part in this world, so far as the formation of the crust of the earth is concerned. It is one of the chief constituents of, and forms an essential part of, all clay. It exists almost everywhere in a greater or less proportion. It is undoubtedly one of the most beautiful elements of which this world is formed, or the external part of it rather.

Aluminium has of late excited a great deal of attention. Formerly it was known only very imperfectly, a few grains only having been obtained. now it is produced by the hundredweight. The metal has a bluish-grey colour,—intermediate between tin and zinc in point of colour, being not so white as tin, and less blue than zinc. It is by far the lightest of all metals now used in the arts, its specific gravity being in round numbers 2·5; that is to say, whatever measure of water weighs 1, the same measure of aluminium will weigh 2·5.

Aluminium has a most powerful affinity for oxygen. When combined with that element, it constitutes the well-known base alumina. Like silicon, although it has this strong affinity for oxygen, yet when we succeed in detaching it from oxygen, and obtaining it in a compact, solid form, it is remarkably stable, and might be exposed indefinitely to the air without undergoing oxidation to any extent. When melted, it oxidizes on the surface and forms alumina. This acts as a coating, and protects the subjacent molten metal from further oxidation.

Aluminium is obtained from a salt termed chloride of aluminium. If we take alumina, which is aluminium and oxygen, and heat it with charcoal even to a high temperature, we cannot, so far as we know, succeed in eliminating the oxygen and detaching the aluminium; but if we make the salt called chloride of aluminium, then we can, by means of a metal having a powerful affinity for the chlorine, succeed in separating the aluminium completely. The first process was to take aluminium and mix that with charcoal, and then to make the mixture into small pellets. Now, charcoal at a high temperature has an affinity for oxygen; and if we expose that mixture of alumina and charcoal at a certain degree of heat to the action of chlorine, we then get chloride of aluminium. We have then two affinities coming into play—the affinity of the oxygen for the carbon, and of the chlorine for the aluminium, and by means of this twofold force we form this body, having a yellow colour, called chloride of aluminium. We then place that chloride of aluminium in a glass vessel, which was the way it was formerly prepared, and expel the air by means of a hydrogen gas, and then introduce the vapour of sodium by a new application of heat to the exterior, in contact with the vapour of the chloride of aluminium. The result is the formation of chloride of sodium or common salt, and the separation of the metal. There is one other source of aluminium from a curious mineral called cryolite—one of the highest possible interest. Here is a specimen from Greenland. This consists of the elements fluorine, aluminium, and sodium. Well, to any mineralogist and chemist who reflected upon its composition, it would naturally occur that, if we could bring that substance into contact with sodium at a high temperature, we should produce aluminium. The thought occurred here some time ago, and the very first specimen produced was produced in this place. That specimen was shown some time ago at the Royal Institution.

Alumina is a compound of oxygen and aluminium. It contains, in round numbers, 53·3 per cent. of aluminium, and, consequently, 46·7 per cent. of oxygen, and its chemical symbol is Al_2O_3. When dry, it forms a white, tasteless powder, insipid and insoluble. This powder is fusible only at the very highest temperatures we can command; in fact, it is singularly infusible. In that state it is entirely amorphous. It has the property of combining with water in several proportions, producing a plastic clay-like mass. Compounds of this kind occur in nature. One hydrate—that is to say, one water-compound of alumina—occurs beautifully crystallized. That is the well-known diaspore. Then we have a non-crystalline variety in the form of Gibbsite. This diaspore is a compound of one equivalent of alumina and one of water. Gibbsite, of which you have a specimen before you, is a white, amorphous, or non-crystalline body, and is a compound of one equivalent of alumina and three of water. Alumina crystallizes magnificently, producing that glorious mineral (excuse the emphatic expression) called corundum, which, when blue, is known to you as sapphire, when red as ruby, when yellow as oriental topaz, and when green as emerald. We have here a specimen of corundum which is coloured, forming these various minerals respectively. We shall speak of the mode of formation presently.

Alumina acts in the twofold capacity of base and acid—that is to say, it unites with acids forming definite salts, and it also acts as an acid forming definite salts. It appears as common alum in the first of these states. If we take the well-known base magnesia, or lime, or oxide of zinc, and mix them with alumina in certain proportions, we get the minerals called spinels, the alumina acting as silica would under corresponding circumstances.

There are various salts of alumina in nature. One of these is wavellite, or phosphate of alumina. Alumina may be precipitated easily by taking a soluble salt of alumina, dissolving it in water, and adding a little ammonia to it; it then forms a dense white precipitate. In that state it is combined with water. It is perfectly soluble in caustic potash, which combines with it, and forms a clear solution.

As far as we know at present, it does not appear that the process of dialysis can have played a very important part with regard to the formation of alumina in nature, or rather in the separation of alumina. Professor Graham has spoken of the dialysis of certain salts of alumina. For instance, one of these is basic acetate of alumina, which may be decomposed by dialysis. The chloride of aluminium is another. There is, however, a salt which he has not examined at present; that is the sulphate, and that is the most likely of all to occur in nature. Therefore, for the present, we have no reason to suppose, from the experiments reported, that this process has any applicability to the formation of alumina in nature.

Now, let us look at crystalline alumina. This is a subject which has a bearing upon geological phenomena. A minute crystal found in a rock shall be a clear exponent of the formation of that rock. However small it may be, it shall tell a most eloquent and indisputable story with reference to its origin. He thought that what he said was not overstated with regard to the formation of some of the mineral constituents, though occurring in small quantity in some of our so-called "igneous" rocks.

The late distinguished, most excellent Professor Ebelmen made numerous experiments upon the subject of artificially-crystallized alumina. He exhibited specimens received from him years ago. They are exceedingly small, but remarkably characteristic. Here are some small scales of alumina crystallized by the operation of fire. The process consists of heating alumina, mixed with about three or four times its weight of borax, in a small platinum crucible, under certain precautions, in a porcelain furnace—a porcelain furnace where we obtain hard porcelain, and not the so-called porcelain which we make in this country, and which is made at a low temperature. It must be the true China porcelain furnace, such as was in operation at Sèvres, where he experimented. He exposed the borax and alumina at a high temperature in this furnace. The borax dissolved the alumina, and after a time off went the boracic acid and the sodium. The crystallized alumina remained at last in brilliant colourless scales. This is exceedingly similar to what is obtained at ordinary temperatures with liquid solvents. It is only just to the memory of poor old Berthier, who died not long ago, to state that the lecturer found, in looking over his papers, that he really was the first man to adopt this mode of forming mineral substances, and obtaining them in a crystallized state. He did not use borax, but he used an equivalent, namely, common salt. He formed crystallized silicate of lime and magnesia by exposing them with salt on precisely the same principle as when borax is used. We are indebted to Deville for that which is now the commonest process, and it is a very beautiful one. The operation is performed in a common crucible. He lines that with charcoal, which is a common process,—what we call brasquing,—thus making an inner lining of charcoal all the way; then above he puts a little capsule or cupel, made of charcoal,—a little cup-shaped piece of charcoal; he then covers the whole with a charcoal top, and afterwards places on the cover, and lutes it down.

In the lower part of the crucible he puts fluoride of aluminium; in the upper part he puts fused boracic acid. He exposes the whole to a high temperature, and the two bodies vaporize. The two vapours come into contact, and they actually decompose each other; and the result is, that the fluorine goes away from the aluminium, and combines with the boron contained in the boracic acid, and then escapes as fluoride of boron, and the oxygen of the boracic acid unites with the aluminium, and forms the beautifully-crystallized substance corundum. Here, then, we can make sapphire in this way most beautifully. At present our artificers have not directed much attention to it, but there is no reason why, if we carried out this branch of investigation, many of our gems might not be produced in this way.

These crystals are generally rhombohedral, terminated by the faces of the regular hexagonal prism, and according to Deville, they possess all the optical and crystallographical properties of natural corundum. Well, then, by just varying this process, we get the true oriental ruby—not the less valuable kind called spinel, but the true characteristic ruby—simply by adding a little fluoride of chromium. The process must be conducted in an alumina crucible,—the boracic acid must be placed in a platinum cupel. Sapphire is produced in exactly the same manner, and the same colouring agent, namely, fluoride of chromium, is made use of. The reason of this is very obscure. Side by side we may get some of the crystals coloured blue, and some coloured red. The difference is possibly due to a difference in the oxidation of the chromium, but that is a point not as yet clearly revealed by analysis. It is a very peculiar thing. The same thing occurs in certain experiments with glass. We know nothing by analysis of the colouring-matter of the sapphire. Whatever it is, it has escaped detection by analysis. Here, by means of the same colouring agents, and under the same conditions, or apparently under the same conditions, we produce sapphire and ruby. Sometimes we find this corundum passing into sapphire, being blue in one part; and jewellers, in setting such things, try with great skill to make it appear that the colourless corundum is coloured, and they set it in such a way that the whole shall appear blue. By increasing the proportions of the chromium salt, Deville obtains a fine, rich, emerald green—an oriental emerald-green corundum. This is simply by increasing the quantity of the chromium. Now, it is very peculiar that we can thus succeed in producing artificially one of the finest minerals, except the diamond. The diamond will come ultimately, no doubt.

Now, there is another process contrived by Debray, which appears to answer perfectly well. This consists of calcining phosphate of alumina with three or four times its weight of sulphate of soda or potash. He gets, then, tribasic alkaline phosphate and crystallized alumina.

Alumina may be melted by oxygen and the flame of a spirit-lamp into glass-like beads, which are stated to be always more or less crystalline on cooling. Gaudin, especially, is the man who, many years ago, experimented upon this subject. The smallest globules show crystalline faces, and they are said to be so hard that their edges will cut glass. Sapphire, whether natural or artificial, is the hardest mineral known except the diamond. Alumina, when melted in the way spoken of, is said to be very liquid. By the addition of a very little chromate of potash during fusion, Gaudin obtained a more or less deeply-coloured red product, similar in colour to the natural ruby. It is reported to be more or less crystalline, and to possess extreme hardness.

Now, how does corundum occur in nature? It is interesting to ascertain this point. It occurs frequently in limestone, forming the so-called stratified granite in Newton, in New Jersey, and in New York. It occurs in layers with marble, in the gneiss of the Isle of Naxos, and also similarly in the Isle of Lemnos, and at Magnesia, in Asia Minor. It is there associated with magnetic iron or crystallized magnetite. It occurs along with diaspore in the dolomite of St. Gothard. It occurs near Ephesus, and also in the Isle of Naxos, in the same way. Here are five specimens of corundum in its opaque, common form. In its finely-divided state it is commonly known as emery, which is nothing more than the common form of the true sapphire. Some of the analyses of this substance give water as an essential constituent, but the sapphire and the ruby are nothing more than crystallized alumina without water. But there are analyses of some two or three specimens of corundum in which we find water given as a constituent. An analysis of corundum from Asia Minor gives 3·7 per cent. of water, and an analysis of corundum from India gives 3·1 per cent. of water. In these cases, probably, they contained diaspore associated with them. There is a difficulty in many of these analyses, and we cannot extract rational formulæ of the results obtained by approximate analysis, because these crystals have the power of enclosing within their mass a very large amount of matter which in no way enters into the chemical composition of the mineral itself. It is there as so much foreign matter entangled in the crystal, and yet the crystal shall have a definite form, and so forth. There is a portion of matter which we must not take cognizance of, but we have no means of separating it mechanically from the mass. It all comes into our results, as we have no way of separating this dirt, as metallurgists call it.

Now for some examples of the so-called aluminates. There is a form of ruby which is an aluminate of magnesia. It is coloured a fine rich colour, apparently with chromate of potash; but of course it is not equal to the oriental ruby. It consists of one equivalent of magnesia and one of alumina. Its formula is, $MgOAl_2O_3$, so that you see that the alumina contains three times as much oxygen as the magnesia. It may be obtained beautifully crystallized, and was so obtained by Ebelmen. It is made simply by heating magnesia and alumina with fused boracic acid, with the addition of a little chromate of potash. The experiment was made in exactly the same way as that with reference to the crystallized alumina prepared in the porcelain furnace at Sèvres, near Paris, already spoken of. Ebelmen obtained in this way distinct crystals of aluminate of magnesia, having a fine ruby-red colour. They are exceedingly small, but they are, nevertheless, instructive, small though they be. Then, by adding a little cobalt, he obtained crystals of the same form, having the characteristic and beautiful blue colour of the natural mineral.

NOTES AND QUERIES.

Typical Mammalia in British Museum.—Dear Sir,—Allow me to point out to you an omission in your list of figured specimens of fossil mammalia in the British Museum ('Geologist,' March, 1864). I have lately described and figured, under the name of *Hyæna antiqua* (Annals and Mag. of Nat. History, January), a molar tooth from the Red Crag of Suffolk, which is now in the national collection. As this announcement may stimulate others to search in the same direction, I trust you will insert it in your journal.—Truly yours, E. Ray Lankester.

8, *Savile Row, W.*

Farringdon Gravels.—Sir,—In his paper on the Farringdon Sponge-gravel, in the January number of the 'Geologist,' Mr. Meyer says that "it is no new idea to compare the Farringdon deposits to the sands and gravel of Devizes" (Lower Greensand). I have always thought that nearly all geologists classed the Farringdon beds with that formation. Mr. Hull has mapped and described them as such in sheet 13 of the Geological Survey Map, and at page 13 of the Memoir, illustrating that sheet with regard to the order of the beds, Mr. Hull says, "The beds at Farringdon are divisible into two groups; the lower being the fossiliferous gravel and conglomerate, the upper, clays and sands, with iron-bands," which agrees with Mr. Meyer's conclusion, that the Sponge-gravel is the oldest of these deposits. I am yours, etc., W. W.

Errata—Mr. Whittaker's Lecture.—Page 58, line 8, after "until" insert "in;" page 58, line 9 from bottom, after "altogether" insert "of;" page 58, line 5, for "supposed" read "supposes;" page 59, line 16, after "Cray" insert "the;" page 59, line 34, before "*London*" insert "*the;*" page 60, line 3, for "abundance Cyrena, Cerithium, and Melania" read "abundance (Cyrena, Cerithium, and Melania);" page 61, line 13, erase the bracket after "common," and insert it after "rays" in the following line.

Cause of the Geysers.—In Mr. Reed's paper "On a New Theory of the Generation of Steam," before the Liverpool Philosophical Society (1862–3), he gives the following summary of the principles laid down by Mr. Williams, the originator of the theory:—

"1st. Water, or its atoms, can neither be *heated* nor *expanded* and still retain the character of liquidity.

"2nd. The prevailing theories as regards *ebullition* are altogether erroneous.

"3rd. The so-called *boiling-point*, as regards temperature, is merely that point at which the water is charged with vapour *to saturation*, under the true Daltonian theory, the water acting the part of a mere *vacuum or medium*.

"4th. We have strong grounds for believing that there is no difference between the *cause* which produces divergence and mutual repulsion among the atoms of a liquid on becoming vapour, and that which produces a similar divergence and repulsion in the pith-balls or gold leaves of the electroscope.

"5th. If there be such a thing as *Thermo-Electricity*, we are warranted in concluding that it acts in the same way, and on a similar principle, on atoms of a liquid as on those of other bodies.

"6th. We have rational grounds for believing that *explosions* in steam-boilers are frequently the result of the accumulated steam (present in the body of the water) being suddenly released by the removal of the pressure from the *denser* medium of the water into the *lighter* one of the air.

"7th. Watt's theory of steam being *condensed*, and reconverted into the liquid state, by the direct action of cold water, is altogether erroneous.

"8th. Vapour or steam cannot give out its heat to water, and is but mixed, *mechanically*, with it, on the true Daltonian theory."

He next applies the theory to the explanation of the Iceland Geysers:—

"They may be," he says, "briefly said to consist of more or less violent discharges of steam and what is called boiling water from subterranean sources, each through an upright tube, which opens out above into a capacious basin. In accounting for these hot springs, the existence of subterranean heat is, of course, always assumed; but opinion has been greatly divided as to the *modus operandi* of its application. One class of writers, of whom Sir George Mackenzie may be taken as the representative, considers that sudden evolutions of heat occur; that these have the effect of generating volumes of steam, which accumulate in cavities with sufficient pressure to sustain the column of water in the Geyser tube; and that further sudden accessions of heat and steam produce vertical oscillations in this column of water, during which the steam finds opportunity to escape, and carries up with it a great part of the water. Another class of writers have adopted a theory put forward by Bunsen, in which the Geyser tube alone, without a subterranean cavern, is supposed to contain water, heat being applied to the tube itself, and the relief of pressure which results from the elevation of the upper portion of the water playing an important part in the operation. In this case, however, as in the former, the notion of steam being *suddenly* generated is preserved, heated rocks being supposed to furnish the necessary supply of local heat.

"Now, Mr. Williams's theory most amply and beautifully accounts for all the phenomena of these Geysers, without assuming the existence either of intense local heat or of sudden evolutions of heat. Simply assuming the existence of a subterranean heat of some kind—and all now admit the existence of that—also the presence of water in and below the tube, and, in his view, the generation and accumulation of steam must take place. As the quantity of this steam goes on increasing, the moment will arrive when the saturation of the water will have taken place, and after that a more or less violent discharge of steam must follow. It seems reasonable to suppose that the Geyser tube is not an isolated reservoir, and that it opens into wells or springs below of greater or less extent; and in this way the enormous amount of the discharges that issue from these Geysers may be accounted for, whereas the tube alone seems of wholly insufficient capacity to supply them.

"I would now ask you to observe the apparatus which we have here, and which Mr. Williams himself constructed. It consists simply of a tube opening into a vessel of water below, and a basin above, the tube and lower vessel being filled with water which rises up and partly fills the basin. Heat is now applied below; steam is, as we think, accumulating in the water; now you hear explosive sounds and observe commotion in the fluid; and now a violent and copious discharge of steam and water-bursts, Geyser-like, from the basin. The action now subsides; the water returns from the basin down the tube to the reservoir below; and presently all these phenomena will repeat themselves, just as they do in nature. The Geyser, then, like the miniature working model before us, consists of a large reservoir below, a single tube or orifice of exit, and a basin above, which receives a large portion of the ejected water, to be returned to the reservoir below. This reservoir being necessarily full of water, the steam generated must remain and accumulate in it until the point of saturation has been reached, which will depend on the height of the column of water in the vertical tube of exit, the temperature in the reservoir corresponding with that elevation. In the miniature, that temperature is found to be 215° when the discharge takes place. In the Geyser, this must be considerably higher, the tube of exit being there 47 feet. We thus see that the Geyser and its miniature correspond in action and result."

SHELL-MOUNDS.—Dr. Collingwood, in the Proceedings of the Liverpool Philosophical Society (1863), says, "My friend Mr. I. Byerley, of Seacombe, has met with remains on the shores of the Mersey, which appear to resemble the deposits known as *kitchen middens*. He informs me 'that strata of shells exist at Wallasey, and in the sand-hills along the shore, between Leasowe and Hoylake, which seem to resemble, on a small scale, the collections noticed by Mr. Lubbock, under the name of 'shell mounds' in Scotland, and of 'Kjökkenmöddings' in Denmark. On going down the hill, just before entering Wallasey village, there is a bank, which may be twenty feet or more high, on the right-hand side; two-thirds of its height is composed of sandstone, above which is a covering of earth from four to six feet in thickness; between the latter and the sandstone, a stratum of mussel-shells, about eight inches thick, may be seen. The shells are partly whole and partly broken; all, of course, are free from epidermis, but the striated colouring is as distinct as in recent specimens of the species. Having, however, lost much of their animal element, they are more friable; and on being placed in water for the purpose of cleansing them, the outer layer of shell-structure readily separates from the nacreous interior. This stratum appears to have no other species of sea-shell intermingled; the terminal whorl and apex of a univalve, however, was just perceptible, which, on careful removal from the matrix, proved to be *Helix aspersa*. This bed is about a mile from the present sea-shore.'

"The same gentleman has also observed either one or two strata of shells in the sand-hills, on the shore between Leasowe and Hoylake. Not having visited the spot for some years, however, he can only report from memory that they are composed exclusively of cockle-shells. It is worthy of remark that these beds are situated very close to the place where the Anglo-Saxon antiquities were found at the Great Meols.

"May we not infer that these shell-strata are composed of the castaway refuse of mollusks, which had been consumed as food by our prehistoric ancestors?"*

MAMMALIAN REMAINS.—Dr. Collingwood, in the course of his paper "On the Ancient Fauna of Lancashire and Cheshire,"† records the following:—*Hippopotamus:* "of which a complete skull is figured in Leigh's 'Natural History of Lancashire' (1705), dug up under a moss" (tab. vi. fig. 4‡). *Megaceros:* "antlers, in marl or gravel, beneath peat," in Lancashire. *Bos primigenius:* from "submarine forest." *Cetacean:* rib of, from excavations at Wallasey Pool; and humerus of a *whale*, from peat of submarine forest, opposite Leasowe Castle. *Cervus elaphus:* Pennant says that horns, "evidently of the stag kind, but much stronger, thicker, heavier, and furnished with fewer antlers than those of the present race, have been found on the sea-coast of Lancashire" (Phil. Tr., No. 422); and a single horn was dug out of the sands near Chester (Brit. Zool., vi. p. 62); four horns from Wallasey Pool. Hopkins transmitted the sketch of an antler to the Royal Society (figured in vol. xxxvii. No. 422, Phil. Trans.); this was drawn out of Ravensbarrow Hole, adjoining Holker Old Park, Lancashire, by the nets of the fishermen, in 1727; similar horns from the submarine forest of Leasowe; other horns described and figured by Leigh in Nat. Hist. Lancas., pl. 5, as "head of a *stag of Canada*" (*i. e. Cervus Canadensis*, the Wapiti), an error; the former being those of the red-deer, found "8 yards within the marle" in Lancashire; and one as huge again, "4 yards under the moss in the Meales;" also others in Camden (Brit., iii. p. 142). *Elk* or *moose-deer* (?), 1845, in submarine forest of Leasowe, according to Dr. Watson, on the identification of Dr. Scouler; also Mr. Geo. Thompson, "head and antlers" in 1857. The specimens are said to be deposited in King's College Museum; but Dr. Pollok, the Curator, says they do not exist in that collection. *Horse:* "almost entire skeleton of a small size, equalling the Shetland pony in height, and remarkable for the large proportion of the head;" found by Mr. E. T. Higgins, of Eastington, Gloucestershire, in the ancient forest-bed of Leasowe; also *Sus*, roebuck (?), and "a dog [or wolf,—S.J.M.] about the size of a greyhound." *Boar:* "tusks, in digging a cellar at Lancaster, in company with Roman remains." *Man:* human skull, in sandy gravel, 10 feet below the original bed of

* Several remains of Mollusca characterize the glacial deposits on the banks of the Mersey, such as *Tellina solidula*, *Nucula oblonga*, Cardium, Nassa, and particularly *Turritella communis*, which passes upward from the sandy gravel of the lower drift deposit into the boulder-clay above. From a well sunk at Poolton, in Wirral, fragments of Mactra, Venus, Astarte (?), and other shells were also obtained.

† Proceedings of the Liverpool Philosophical Society, 1863, part xvii.

‡ Also figured by Buckland in Rel. Dil. part xxii. fig. 5, and mentioned by Owen in Br. Fos. Mam. p. 401.

Wallasey Pool, and "in close connection with the ancient fossil oxen above referred to."

Mr. Haswell on the Denudation of Arthur's Seat.—My attention has been drawn to an article which appeared last Saturday in a weekly contemporary. That article was entitled "Geological Plagiarism," and commented on the appropriation of passages and ideas from Mr. Geikie's contribution to the geology of Edinburgh in the 'Memoirs of the Geological Survey' for 1861 in the article printed in the number of this magazine for the past month "On the Denudation of Arthur's Seat." No one will, I am sure, believe me capable of knowingly permitting such plagiarism to appear in these pages; and even the writer of the criticism referred to in no way attempts to put such an imputation upon me. As far as I am personally concerned, I was in total ignorance of the existence of Mr. Geikie's paper. The publications of the Geological Survey appear in a very erratic manner, and as I am in no way personally interested in Scottish geology, and do not, as I think as editor of this magazine I ought to do, receive gratuitous copies of the works issued by our national survey for review, I naturally only purchase such portions as I have individual need of. Such is the brief explanation of the cause of Mr. Geikie's paper not being known to me.

Having been visiting the scene of the late disaster at Sheffield, it was only since my return that I knew of the article in the contemporary referred to. I at once forwarded a copy of the article to Mr. Haswell, who is not personally known to me, with the request that he would take the matter up. Time sufficient for his reply not having elapsed, it will be obvious that further remarks of mine at present would be unjust to a contributor, and could be neither sufficient for my own wishes, nor for that due apology which, if the case be truly stated, is undoubtedly due to Mr. Geikie. S. J. Mackie.

26th March, 1864.

Works of Art in Caverns in Central France.—Dr. Falconer has communicated the following letter to the 'Times:'—

"Sir,—Since the exploration of the Brixham Cave in 1858 an immense impulse has been given all over Europe to the search for and study of the material proofs of the antiquity of the human race. The public mind is now craving for information on a subject which a few years back was condemned by the general verdict of men of science, and hardly mentioned except in a whisper. Fresh evidence is being brought to light, day after day, of the most interesting and important character, although not tending to carry man back, in every particular instance, to a period of very high geological antiquity. The south of Europe is the quarter whence the current is now flowing, and the ossiferous caves the springs whence it issues. Professor Busk, in a recent communication ('Reader,' 30th of January) has given a very clear and excellent account of discoveries made within the last year in a bone-cave in Gibraltar. The materials, not all yet arrived in England, are now under investigation, and give promise of results of high import But the most interesting additions have been yielded, very lately, by caves in Central France, where what may be called works of art, of primitive execution, have turned up in considerable abundance, which prove that savage man, of the unground and unpolished stone period, was able, in advance of the use of metals, to sculpture on deer's horns, and to grave on stone, figures of quadrupeds his contemporaries that are now extinct in that region. My friend M. Lartet, on behalf of himself and Mr.

Henry Christy, his *collaborateur* in the work, communicated to the Academy of Sciences on the 29th ultimo an account of these relics, which, when exhibited, produced an unusual sensation among the learned Academicians. I purpose now giving a brief sketch of this new and certainly very ancient walk of art, drawn mainly from M. Lartet's paper, which will speedily appear in the 'Comptes Rendues' and from figures of the objects.

"The proofs of the remote antiquity of man are derived from two sources —1, the ancient, or 'quaternary,' river gravel-deposits; 2, the ossiferous caves. The former, handled with the severe caution of Mr. Prestwich, carries man furthest back in time, and with the greatest certainty; but it is of the most meagre and restricted character, consisting merely of flint weapons or implements, hardly ranging beyond a few patterns. Not a single instance has yet occurred of a fragment even of an unquestionably authentic human bone having turned up in these deposits. On the other hand, the evidence yielded by the caves, although less certain as an index of remote time, is infinitely more varied and instructive. It tells us, in certain cases, the division of the human race to which man, the early tenant of the caves, probably belonged; what was his stature and what his physical powers; what the animals which were his contemporaries; what the mollusks, fish, flesh, and fowl upon which he fed; that he cooked his meat by fire; that he extracted the marrow from the bones, and how he did it; how and with what weapons he killed his game; how he flayed and dressed the hides; that he scraped the meat off the bones; that he carefully cut the sinews of his slaughtered deer for harpoon lines, or for the fibre of sewing-thread for his fine-pointed pierced needles; where and in what direction he cut the sinews; what the implements and weapons—in stone, bone, and deer's horn—which he used; what his ornaments, and how he disposed of his dead. It is now beginning to enlighten us on what he was capable of achieving in the way of art, and that in music he had got the initial length of a bone whistle limited to a single note. The cave evidence has been disparaged by cursory observers and light reasoners, upon the grounds that the caves have been occupied at different times, and their contents often disturbed by the latest tenants, thus forming what are called *remanié* deposits. But the shortcomings lay with the objectors themselves. When the profound palæontological knowledge, rare sagacity, and philosophic caution of M. Lartet are applied to what were sources of doubt and embarrassment to them, the supposed difficulties are converted into aids in unravelling the tangled clue, and into indices of ulterior truths. In short, beside the bare fact that primeval man existed during the early 'fluviatile drift period in Europe,' all that we know of him—exclusive of the later 'kitchen-middens' and 'pile-habitations'—is derived solely and entirely from the ossiferous caves.

"The caverns which, on this occasion, were the objects of exploration by M. Lartet and Mr. Henry Christy, occur in the department of the Dordogne (the ancient province of Périgord), and in the arrondissement of Sarlat, in the south-western part of Central France. The most productive localities were the cave of 'Les Eyzies,' in the commune of Tayac, the cave of 'Le Moustier,' and the shelter-recesses under the projecting cliffs of 'Laugerie-Haute,' 'Laugerie-Basse,' and 'La Madeleine,' in the valley of the Vezère; the rock-formation consisting of indurated chalk. The floor of 'Les Eyzies' cavern is overlaid by a continuous sheet of breccia, composed of a base of cinders and ashes, mingled with charcoal; fragments of bones either in the natural state, or split, scorched, or burnt; outside pebbles; flint cores with numerous fragments of flint flakes or knives, invariably of wrought forms, and associated with other implements or weapons fabricated out of reindeer's horns; the whole consolidated in a confused mass, which had never been disturbed since the period of deposition. This was established by the state of the materials and by the fact that in several cases long bones were found with their heads in articular continuity, and vertebræ of reindeer in sequence.

"The principal objects of art were as follows:—In 'Les Eyzies' among numerous fragments of a hard slate, foreign to the district, two plates were found, each bearing an engraved representation of a quadruped. One of them, mutilated by an ancient fracture, presents the fore-quarter of a herbivorous (?) animal, the head of which was apparently invested with horns, so far as the faint lines of the engraving at this part admit of judging. The other bears the figure of a head, with the nostrils sharply defined, and the mouth half opened; but the profile lines of the frontal region are interrupted in consequence of erasure by subsequent friction. On one side and a little in front is engraved the figure of the palm of a large horn, inferred by MM. Lartet and Milne-Edwards, with reserve, to be that of a moose deer. These specimens are regarded by M. Lartet as being the earliest known examples of engraving on stone, by primeval man, of the reindeer period in Europe.

"The most striking part of the collection, consisting of sculptured objects, was discovered in the shelter recesses, under the cliffs of La Madeleine, Laugerie-Haute, and Laugerie-Basse, amidst accumulations of bone-refuse and other *rejectamenta*, mingled with an immense quantity of flint flakes and the cores from which they were struck off. These spots were evidently the kitchens and manufactories of the ancient savage. The bones indicated the animals on which he fed: being the horse, ox, ibex, chamois, reindeer, birds, fish, etc. The common stag was rare, as were also the boar and the hare. Some detached molar teeth were discovered of the extinct Irish elk, and also detached plates of the molar teeth of the mammoth.

"Laugerie-Haute would seem to have been especially the locality were flint implements were made, and Laugerie-Basse that where reindeer horns were converted into spear-heads, harpoons, daggers, arrow-heads, needles, and other implements. Here an enormous accumulation of reindeer horns was discovered, the whole of which nearly bore the marks of a stone-saw, by which pieces were detached suitable for conversion. Here also were found the principal sculptured objects, some of which, considering the period and the nature of the tools, are marvels both of artistic design and of execution.

"The most remarkable is a long dagger or short thrust-sword, formed out of a single horn. The handle represents the body of a reindeer, the parts in fair proportion, and treated with singular skill and art-feeling, in subservience to the use for which it was intended. The fore legs are folded easily under the body; the hind legs drawn out insensibly into the blade; the salient horns and ears are cleverly applied to the chest by giving an upward bend to the head; and a convenient hollow for the grip of the hand is produced by a continuous curve extending from the rump to the muzzle. M. Lartet remarks that the hand for which it was designed must have been much smaller than that of the existing European races. The weapon was evidently left by the artist-savage unfinished; but, as a design imbued with taste, it will bear a very favourable comparison with Oriental dagger-handles cut in ivory.

"Another specimen is described as a handle terminating at one end in a spear point, and bearing in partial relief the heads of a horse and of a deer, probably reindeer. Others are ornamented with longitudinal and parallel wavy lines, etc. A distinct class consists of palmated portions of reindeer horns, bearing representations of animal forms,—some executed in graved lines, others in bas-relief or in high relief. One of these palmations exhibits a figure of a large herbivorous animal which has been conjecturally referred to the Aurochs. Another is supposed to represent an ox, probably *Bos primigenius* (?). The collection, judging by the drawings which I have seen, is very rich in spear-heads, barbed harpoons, arrow-heads, and finely pointed slender needles, drilled with an eye-hole. The harpoons bear a close resemblance to the Esquimaux patterns. On one object the figure of a scaly fish is distinctly represented. The ornaments consist of canines of wolf, incisors of ox and other animals, with ear-bones of horse or ox, all drilled for suspension. One curious object is the first digital phalanx of a ruminant, drilled to a certain depth by a smooth cylindrical bore, on its lower surface near the expanded upper articulation. This is supposed to have been a whistle or call, and a shrill sound is yielded on applying it to the lower lip and blowing into it. Three of these whistle phalanges are of reindeer, one of chamois. One relic of surpassing interest consists of the lumbar vertebra of a reindeer, pierced through and through by a flint weapon, which still remains embedded in the bone, fixed by calcareous incrustation. This is an object of great significance and extreme rarity. Human bones, although found, were very scarce; but M. Lartet has refrained from alluding to them, with a reserve the reason of which is indicated by M. Milne-Edwards. In forming an estimate of the value of the relics of art, the reader will bear in mind that they are the productions of the unpolished and unground 'Stone period;' the tools employed having been thin chips and delicate flakes of flint. Such, at least, is the fair inference drawn with our present lights from the negative evidence, not a trace of metal in any shape having been met with in the Dordogne Caves. But if primeval man really had made such progress in the conceptions of art without having yet attained the knowledge of metals, it will be as curious an anthropological phenomenon as are the art objects themselves, which express that degree of luxury which ease, leisure, and comfort beget. Reindeer's horn is notoriously the most worthless and incompact of cervine antlers; it is readily whittled by a knife, which is not the case with stag's horns.

"The labours of M. Lartet and Mr. Henry Christy on the Dordogne Caves commenced in August, 1863. They have been continued ever since, and are still in progress. Valuable and instructive as is the Dordogne collection, it is surpassed in certain respects by another, from the 'Bruniquel Cave,' in the south of France, more recently formed by other observers. The Bruniquel series, it would appear, does not embrace the same range of art, but it is richer in the department of weapons and implements, such as harpoons, spear-heads, etc., which are larger, more numerous, better finished, and in better preservation. These precious materials were offered in succession to the French Government and to the British Museum. 'Perfide Albion' has got them: they are now in the national collection. The result does infinite credit to the zeal, enterprise, and activity of the administration of the British Museum. But the satisfaction which so valuable an acquisition necessarily excites is not wholly unmixed. The investigation of truth is above and beside national predilection. The 'Bruniquel Cave' series is now divorced from the collections in France, of which it forms a complement, and upon which M. Lartet has been engaged since 1861, when he published his important researches on the Sepulture-Cave of Aurignac.

Those who take an interest in the advancement of our knowledge of the subject would have congratulated themselves if the Bruniquel materials had been placed in his practised hands, to be included in the work which he and Mr. Henry Christy are about to publish on the ancient remains of man of the 'Cave' period in France.

"One circumstance in the case deserves to be generally known. The instinct of a collector is to amass, hoard, and retain. Mr. Henry Christy is the possessor of one of the choicest private archæological collections in Europe. M. Lartet and he explored the Dordogne Caverns on a large scale, with the object—first of exhausting the ground, and next of distributing duplicates. They have presented huge slabs of the floor-matrix, containing embedded every variety of object, to all the principal museums in Europe, and selected sets to persons of all countries having a recognized position as labourers in the same field; and this, too, before their own researches were published. In their case a higher impulse extinguished the mere collector's instinct. No comment is required.—Sir, your obedient servant, H. FALCONER.

"21, *Park Crescent, Portland Place, March* 10.

"P.S.—At the meeting of the Academy of Sciences (February 29) a note on the same and cognate subjects was communicated by the Marquis de Vibraye, who has laboured so meritoriously on the ossiferous caves of France."

ON SOME FORAMINIFERA FROM THE TERTIARIES OF TRINIDAD.—At page 38 of the 'Report on the Geology of Trinidad' is given a figure of a remarkable stratum of asphaltic rock. This stratum is nearly vertical in position, and projects from the cliff to some little distance into the waters of the Gulf of Paria. Though a considerable part of it has been removed since the drawing referred to above was made, it yet seems to possess a superior power of resistance to the encroachment of the waves than the remaining portions of the cliff. Upon a close examination the vertical mass is found to consist chiefly of the remains of Nummulites and Orbitoides, two genera of Foraminifera, whose shells, as is well known to geologists and palæontologists, form in various parts of the world thick masses of rock; the Orbitoides being generally characteristic of the Eocene period in the western hemisphere, while the Nummulites are regarded as indicative of the Middle Eocene in Europe and Asia. Here, however, we find the remains of both these generated in strata of supposed Miocene age.* *Nummulites* is regarded as a strictly Tertiary form of Rhizopod, while Orbitoides has been found in the Chalk or Upper Mesozoic deposits, as well as in the Lower Tertiary formations.

Of the *Orbitoides* vast numbers are contained in the San Fernando Tertiaries. They are found alike in the gypseous marls which constitute so large a portion of those deposits, and in the asphaltic portions of the group. In the marls they chiefly occur in the nodular concretions, and in the indurated veins and layers. In the singular mass of rock figured by Messrs. Wall and Sawkins, the Orbitoides seem to form the greater part of its bulk. They are not referable to any species of which I have seen figures. The Nummulites found in the same deposit present a decidedly close resemblance to *N. lævigata*, but the chambers seem to be, in the San Fernando specimens, larger relatively to the size of the whole shell. When a portion of the rock is submitted to heat, and the asphalte thus driven off, the Nummulites generally fall into two pieces, each of which presents a

* Report on the Geology of Trinidad, pp. 85 and 162.

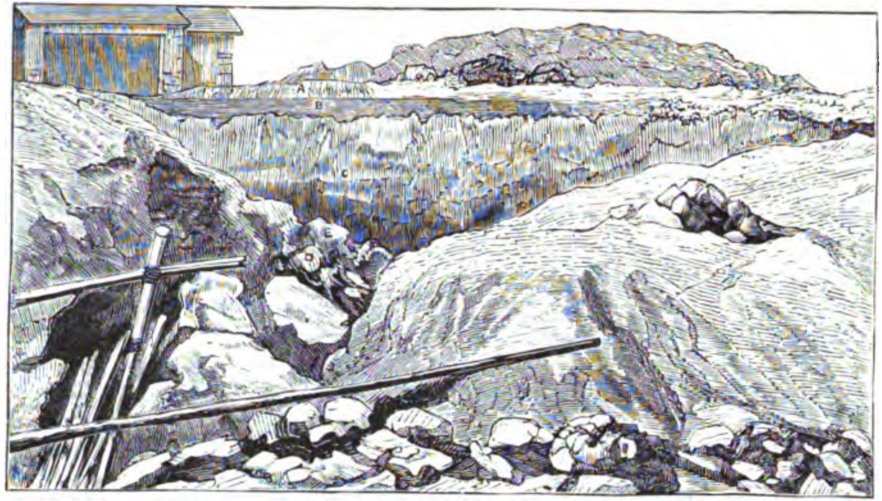
transverse section of the shell, showing distinctly the chambers which, during the life of the animal, contained its softer parts. Were it not for this circumstance, it might have been difficult to have obtained sections of these shells, as owing to their fragility they would scarcely bear the process of grinding down, however delicately conducted.

Some specimens of Bryozoa have occurred among the Orbitoides, but I have not succeeded in detaching a specimen. They are so brittle that the most careful manipulation is insufficient to prevent them from falling to powder under the hand of the operator. I have not detected any other organisms in the same bed as the Orbitoides and Nummulites; but both above and below it are found Tertiary fossils, probably not of more recent date than the Miocene age. I hope to be able to present observations on these fossils at some future time. Suffice it for the present to state that the evidence derived from them is not inconsistent with the presumption of the Miocene origin of the deposits in question. We know too little as yet of the Tertiaries of this part of the world to be able to pronounce a more decided opinion; but should the supposition of the Middle Tertiary age of the San Fernando Tertiaries be ultimately established, we should have here the remarkable phenomenon of the association of an Old-World with a New-World form of Lower Tertiary Rhizopod in a deposit of Middle Tertiary age. It would indeed be very possible, in that case, that the homotaxical representatives in Europe of the deposits at San Fernando may be found amongst the lower members of the Miocene group. But this observation would not necessarily extend to those portions of the Tertiaries which are found inland, at Mount Tamana, Jordan Hill, and St. Croix, for instance. The fossils from those places, as well as those from Manzanilla, and other parts of the east coast of the island of Trinidad, seem to belong to a somewhat later date.—R. J. Lechmere Guppy.

MISCELLANEOUS NOTICES.

The "Rules for Zoological Nomenclature," elaborated by the Strickland Committee of the British Association in 1842, have been reprinted in a pamphlet-form, under the authority of the British Association, by Messrs. Neill, of Edinburgh. The vagueness and uncertainty of the nomenclature of animals has been one of the greatest detriments to science, and before the framing of these rules was infinitely worse than it is now. Indeed, so long as naturalists take different views of the natural affinities of animals, there must and will be diversities of classification. The widest circulation and the universal adoption of this series of propositions will be the best antidote for the evils arising from still continued injurious practices. The object of the present issue is to get suggestions for the amendment and perfecting of the rules submitted to Sir W. Jardine and the new committee, before the next meeting of the Association in June.

The Proceedings of the Liverpool Philosophical Society contain—"The Ancient Fauna of Lancashire and Cheshire," by Dr. Collingwood; and "On a New Theory of the Generation of Steam, with an Explanation of the Geysers of Iceland," by Mr. E. J. Reed, H.M. Chief Naval Constructor; and "On the Manufacture of Stone-Implements in Ancient and Modern Times."



SECTIONAL VIEW OF STRATA AT SHIRLY QUARRY. By GEORGE MORANT, Esq.

THE GEOLOGIST.

MAY 1864.

DR. FRANKLAND ON THE GLACIAL ERA.

By the Editor.

Some of the novelties presented at the lectures at the Royal Institution have, from the hour they were spoken, taken rank with the discoveries of the age and the data of science; amongst such are some of the most important results of the researches of Davy, Faraday, and Tyndall. Others, as might be naturally expected, have risen to no higher rank than that of hypotheses or an hour's amusement, and after exciting some discussion and comment, have passed away into that oblivion to which all but fundamental or practically useful facts are, sooner or later, consigned. Amongst those familiar voices which we are there in the habit of hearing, few are listened to with more pleasure, profit, or instruction, than that of Professor Frankland, especially when he restricts himself to those branches of chemistry in which he is so eminent. The Glacial period and the former incandescence of the earth are two themes that geologists are eternally dwelling upon—whether with profit to themselves or with any advantage to their hearers it would be very difficult to say. For once Professor Frankland has left those realms of chemistry within which he is a monarch to run a lance at the same time both for and against geologists. Basing a theory on the supposed existence of an internal molten mass constituting the core of our globe, is taking for it about as secure a basis as any one might be presumed to have who attempted to balance his body at the top of a mountebank's pole, the other extremity of which was held by infirm and trembling hands. His body might be put in proper attitude and position, and duly manœuvred to acquire exactness of balance; but if the shaky hands gave way, the fall might be sudden and severe. The supposed fire-origin of granite was one of the original causes of the invention of the internal-heat theory; but modern researches have distinctly shown that certainly one at least of the petrological elements of that rock—namely, quartz—as seen now as a constituent of that very granite, never could have been subjected to the influence of dry heat. Another difficulty arises in respect to the internal molten state of our earth: if the core of our globe be in that condition, it would follow there must be internal tides, unless the solid crust of the earth were of immense thickness, and of a rigidity, at least, four times that of steel; for not less than that would suffice to resist the internal tidal tendency, taking the thickness of this crust as estimated by Mr. Hopkins. It is evident beyond question that a liquid mass, whether fluid at ordinary temperatures, such as the waters of the ocean, or rendered fluid by internal heat, must be equally subject to the laws of attraction; and consequently the moon would have an influence upon the internal molten core, as she has upon the external oceans.

Now, Professor Frankland—repudiating all the explanatory theories which have been hitherto given to account for superficial differences of temperature, from Lyell's different distribution of land and sea doctrine, to that of the higher elevation of all mountainous tracts during the Glacial age suggested by Professor Kāmtz—based his new hypothesis on what he regarded as the incontrovertible fact of the internal molten fluidity of our earth. The descriptions of the fiords and the ice-scored land of Norway, which Dr. Frankland has lately visited, were exceedingly interesting and instructive; but when the Professor came to deliver his new hypothesis, we at once felt ourselves launched on the waves of an unnavigated sea, and saw many reasons why the bark of the adventurous *savant* should be deemed too frail for geologists to venture in. To say that the hypothesis was ingenious is only to give it its just meed of praise; to say it was substantial is quite another thing. It was this:—We are all familiar with the ordinary still. There is the boiler where the vapour is raised, the spiral tube in which it is condensed, and the receiver into which the condensed fluid falls. Compare the earth, its atmosphere, and its mountains to the still. From the ocean the vapour rises; "the atmosphere," says Dr. Frankland, "is the true condenser, for the aqueous vapour that rises in it to its utmost heights *radiates its heat* into space; the mountains are the receivers of the rain and snow precipitated." So far we have no objection to the doctrine. But to apply it practically to the production of the phenomena of the "Glacial period," which everybody knows was a geological period of intense cold, almost immediately preceding our own historical age, and possibly, according to recent ideas, absolutely including the early portion of the human era. Before this, according to the general tenor of geological notions, the earth had from the beginning of time possessed a gradually diminishing but still always higher temperature than it does at present; but whether this doctrine is not, upon stratigraphical evidences, open to grave doubts, we are by no means sure. Admitting this, for the sake of the argument, we have to see how Dr. Frankland applies Professor Tyndall's radiant-heat principles to the production of a *period* of intense cold.

The points which he deemed his theory must meet are thus stated. The glacial phenomena must extend over the *whole* globe; their occurrence must be of geologically *recent* date; they must have been preceded by ages during which glacial action was wanting; and they must be followed by a time during which there was a re-tendency towards an ameliorated condition of temperature. Moreover, Dr. Frankland considers it essential to show that during their continuance atmospheric precipitation was greater, and the snow-line lower, than at present. All these conditions, Dr. Frankland asserts, would naturally result from the gradual cooling of our planet; so that, according to his view now put forth, "the sole cause of the phenomena of the Glacial epoch"—or period of universal intense cold all over the earth—"was a former higher temperature of the ocean than that which obtains at present." Admitting that our globe was once so hot that all the water now in it was then *in nubibus* and not in the ocean cavities at all, he goes on to its first condensation into liquid, and then from the cessation of the boiling of the seas through a gradual diminution of temperature down to their actual state; a corresponding refrigeration of the land being contemporaneous. It was, he says, during the later stages of this cooling operation that the Glacial epoch occurred. For this result, however, he is constrained to the assumption that the earth and the sea-water have cooled at different rates. To prove this he brought forward experiments upon the differences of cooling between a cube of granite and one of water respectively heated to a given temperature, and then timed for the periods that elapsed in the giving out or radiation of the heat they had imbibed, for a reduction of ten degrees. These experiments we are so obtuse as not to see the corroborative force of, for it may be asked whether, if it take five times as much heat to raise one body to the same temperature as the other, we might not expect to find one body proportionately longer than the other in parting with the heat it had obtained. It seems to us that the experiments would have been more to the purpose if a mass of molten lead had been covered by an iron-bottomed trough of water, in which a given mass of granite soldered down to the intervening iron plate had been partially immersed. Such, at any rate, would have been conditions more nearly resembling those presumed for our earth.

Of course, the nebular hypothesis of the formation of stellar globes from the condensation of vaporous matter in space, and the evolution of light and heat in the process, was brought in as the primary origin of the presumed internal molten state of our earth; but it will be well to bear in mind that our largest telescopes have resolved, one after the other, the numerous luminous patches in the vast heavens into gigantic clusters of sun-stars, and that up to this moment there is no proof whatever of any former nebulous state in our own or any other solar system. Nor was the oft-quoted nebular hypothesis the only support Dr. Frankland tried to get from astronomy. He has been searching the moon for more than a year with a reflecting telescope of 7 inches aperture, and has found *two* streaks on her surface, which he thinks may be the marks of glaciers with their terminal moraines. One of these fancied moraines is at the termination of that remarkable streak which commences near the base of the gigantic crater Tycho, through the ring of which it breaks,—a fact not omitted in Dr. Frankland's illustrating diagram, and which would alone much more naturally assign its origin to the class of volcanic phenomena. The other extends from Rheita, the crater-rim of which is also broken down, as it would be by the passage of a lava-stream. But as the author of the new hypothesis admits that, "with regard to the probability of former glacial, or even aqueous, agency on the surface of the moon, difficulties of an apparently very formidable character present themselves," we need not pursue further these lunar fancies—for such we cannot help regarding them.

It will naturally occur to those who are not familiar with ice-making machines, that if warmer water in the sea will produce a universally colder climate, and an equally wide-spread lower descent of the line of perpetual snow on our mountains, that when the sea was boiling, and the evaporation yet more abundant, the colder still should have been the condition of our planet's land-surfaces, until, in fact, the snows of the land should have touched the waters of the boiling ocean, and have melted only on the margins of its shores. This argument would indeed have been viewed as the *reductio ad absurdum*; but the Professor does not bring us quite to this dilemma. He presumes the radiant heat of the earth was sufficient to drive outwards the upper atmospheric sphere of radiation and condensation far above and beyond the loftiest mountains. We give the conclusions to which these speculations lead their author—namely, "that a liquid ocean can only exist upon the surface of a planet so long as the latter retains a high internal temperature." "The moon becomes thus," he says, "a prophetic picture of the ultimate fate which awaits our earth when, deprived of an external ocean, it shall revolve round the sun an arid and a lifeless wilderness." A not very comforting prospect truly, which we doubt not will be very long indeed before it commands popular assent.

ON REMAINS OF THE *MEGACEROS HIBERNICUS* IN GYPSUM IN IRELAND.

By David Leslie, M.D.

The "Irish Elk" has been hitherto only found in the shell-marl underlying extensive turbaries. It is a true deer, intermediate between the fallow and rein-deer. In England it has been found in lacustrine beds, brick-earth, and ossiferous caves (Owen). The subject of the present paper is a dorsal vertebra belonging to a skeleton quite as large, if not larger than the specimen in the College of Surgeons Museum, London, with which it was compared. It was found on the Shirly property, in a bed of gypsum, county of Monaghan, Ireland. This gypsum-bed is very extensive, being many square miles in extent, underlying the glacial drift, embedded in and sometimes alternating with a fine ferruginous clay. The subjacent rock is the older or lower coal sandstone, which lies unconformably on the mountain limestone, which reposes on the Silurian, the latter forming hills of 500 or 600 feet elevation in the immediate neighbourhood. The surface-soil is formed of ancient drifts of different ages, the one containing enormous blocks of mountain limestone, the other, the older, more compact, and containing small fragments, very rare, of a limestone, which, from comparison, is supposed to have been brought from the counties of Tyrone and Fermanagh, by a current that denuded all the western aspects of the Greywacke ranges of hills, producing very markedly the phenomena of "crag and tail," which are there to be seen in endless examples.

On the summits of many of the drift-hills are found some enormous blocks of mountain limestone, evidently deposited from floating icebergs, which ran aground in the shallow waters as these hills emerged from the deep, and there deposited their gigantic burdens as the ice melted away.

The accompaning sketch (Pl. XI.), made by George Morant, Esq., Shirly House, gives the true relative position of the fossil. The vertebra was found embedded in gypsum, about 1 foot below the surface of the gypsum rock. The section in the plate gives—alluvium 2 feet; peat 1; glacial drift 6; gypsum 1 foot; then the vertebra in the rock, which extends downwards to a thickness of 40 feet. Thus we find an unquestionable vertebra of *Megaceros Hibernicus* embedded in solid gypsum, of an age much older than any glacial drift. The total absence of fossils in the ferruginous clay and gypsum, which are of contemporaneous origin, made it impossible to give any other than a stratigraphical age to the bed, in which the vertebra was found, it being placed beneath the oldest drift and lying on the lower coal-sandstone. The Irish Elk is therefore of much greater geological antiquity than what has been hitherto supposed.

Tunbridge, April 2, 1864.

NEW SPECIES OF TEREBRATELLA, FROM THE BARGATE STONE.

By Mr. C. J. A. Meyer.

I send some drawings and a short description of a pretty little Brachiopod from the Lower Greensand of Godalming, of which, unfortunately, I possess at present only a few single valves, viz. 7 dorsal and 4 ventral valves. These are, however, sufficiently perfect to enable me partially to describe the shell, and I take the present opportunity of so doing, with the hope that, at some future time, better specimens may come to light. (See Pl. XII. Figs. 1–6.)

The species is apparently new, local in distribution, and, so far as I am at present aware, confined to the "Bargate stone" of Guildford and Godalming, the position of which is near the base of the ferruginous or upper division (of Fitton) of the Lower Greensand. From the partial outward resemblance of this shell to that of *Terebratella Menardi*, and from the fact of the hinge line and medial septum in the dorsal valve being of the same form in both, I am inclined to consider this species as a Terebratella: the peculiar form of the dorsal valve has suggested its specific name.

Terebratella trifida, n. sp. Shell (judging from a comparison of several single valves) as wide as long, in old specimens perhaps rather longer than wide; convex in both valves: dorsal valve moderately convex, and divided into three portions; a large, elevated, mesial fold, in the shape of an acute rib, occupying the entire central division, on either side of which, on the lateral divisions, there exist one or two ribs of small elevation, followed occasionally by a third of still smaller size; the whole being crossed by numerous concentric, strongly marked lines of growth. The hinge line is but slightly curved.

The ventral valve is much deeper than the opposite one, has a deep angular sinus, and on each side of the lateral portions of the valve, two or three ribs; the beak seems to have projected but little, in one of my specimens appearing to have been truncated almost as abruptly as in *T. Menardi*, and showing evidence of a small flattened space or hinge area between its ridges and the hinge line: the foramen is rather large.

The interior of one of the dorsal valves exhibits a small, elevated, longitudinal septum, commencing from beneath the hinge plate, and extending to nearly half the length of the valve. Shell-structure punctuate.

Dimensions.—The largest dorsal valve in my possession measures 4½ lines in breadth by 4 in length; another specimen measures 5¼ lines in breadth by 4 in length; the largest ventral valve measures 5½ in breadth by the same in length, and, as in this specimen the beak is nearly perfect, one may suppose the length and breadth in this species to be nearly equal; the greatest breadth of the shell is usually close to the hinge line.

Approaching most nearly in form to *T. Menardi*, this species is, however, readily distinguished by its very large and simple mesial fold.

The two first examples of this shell I obtained from a small quarry near Tewsley, south of Godalming; the others are from a quarry about a quarter of a mile west of St. Katherine's Hill, near Guildford, where it occurs in company with *T. Menardi*, Lam., *T. oblonga*, Sow., and *Terebratulina striata*, Wahl., var. (*T. auriculata?*, D'Orb.); these are, however, all extremely rare.

8, *Church Buildings, Clapham Common.*

Explanation of Plate XII.

Fig. 1. Dorsal valve, magnified; 4. Front view of ditto; 5. Another dorsal valve; 6. Interior of ditto, with medial septum; 2. Ventral valve; 3. Ditto, side view.

CORRESPONDENCE.

Geological Plagiarism.

The following copy of a letter published in the 'Reader,' has been sent to us for insertion:—

"GEOLOGICAL PLAGIARISM.—To the Editor of the 'Reader.'—Sir,—Under this head I observe a letter in the last impression of the 'Reader,' which is by no means flattering to myself, and I would therefore now beg to make a few remarks by way of explanation. 'F. G. S.' is not incorrect in supposing that he 'had seen the same ideas, and possibly some of the same expressions, not long before in the Memoirs of the Geological Survey.' I acknowledge the similarity of idea in the passages quoted by him, and the sameness of expression of which, in one or two cases, as a student and a beginner, I have been unfortunately guilty, and which, but for an oversight, would have been indicated by inverted commas. But when I show how that has arisen, I hope 'F. G. S.' will understand my excuse; and should this meet the eye of Mr. Geikie, that that gentleman will accept my apology. On reading over, some time ago, the Geological Survey's Memoir on Edinburgh, I was struck with Mr. Geikie's remarks on 'Denudation' in chap. xiii., which, by the way, applied to Midlothian generally, and not to Arthur's Seat in particular. The idea which more especially attracted my attention was that Midlothian had been subjected to a process of denudation at two different and widely-separate periods in geologic time, and as I happened to be studying the geology of Arthur's Seat at the time, I naturally desired to have a clearer idea of the effects of denudation on that particular hill. The result was the paper in question, which, as you can easily imagine, was written in the spirit of Mr. Geikie's remarks, but at the same time with the desire to give greater prominence than he has done to the idea above-mentioned. The *plan* of my paper is quite different from the chapter in the Memoir, and is all I ever intended to 'be regarded as original.' I certainly ought to have mentioned the source from which I had gathered a portion of my information, and herein I confess I have made a mistake; but at the same time 'F. G. S.' and Mr. Geikie will remember that these ideas on the denudation of Midlothian are by no means new, but have been more or less entertained by our local geologists for some time back, and have even been made the subject of papers before the Edinburgh societies, as my own was before its appearance in the pages of the 'Geologist.'—I am, Sir, yours respectfully, JAMES HASWELL.

"*Edinburgh, 23rd March,* 1864."

The Eternity of the Universe; in Hebrew Phraseology, of the Heavens and the Earth.

SIR,—After many years' reflection upon the subject, I have come to the conclusion that the true Scriptural doctrine—which at the same time commends itself to reason—is, that the universe (in Hebrew phraseology, the heavens and the earth) is eternal; in other words, that as there always has been and will be a God, so there always has been and will be a universe,—in Hebrew phraseology, an earth and heavens. I have come to the opinion, that where geology ends, there the Mosaic record begins. This interpretation is exceedingly simple, and removes all difficulties. We have only one question to deal with, and that a very simple one, namely, does the Mosaic record on the one hand, and geology on the other, testify to the same condition of the earth at the only point where they come in contact? This question can be answered in a few words.

Moses says, "In the beginning God created the heavens and the earth. Now the earth it was a wreck and a ruin; and darkness (was) upon the face of the deep; and the spirit of God (was) hovering over the face of the waters."

The meaning of these words will be best seen in the following paraphrase:—

"The following is the true history of the creation of the heavens and the earth:—They were created by God, and they were created in six days. At the time when their creation commenced the earth was in a truly deplorable condition. It was a wreck and a ruin. The ploughshare of ruin had passed over it, leaving it waste and desolate, dark and damp. Murky vapours ascended from the abyss of waters, effectually shutting out the light of day. Being deprived of light, the earth was destitute of heat; consequently animal and vegetable life was extinct. The Spirit of God regarded the earth in this its desolate condition with tender solicitude, even as a mother-bird hovers over her young when in misery and pain."

According to the exposition of the learned commentator Macknight, 2 Pet. iii. 5, 6 is a parallel text, referring to the period of the Drift, or, as it is sometimes called, the period of alluvial and diluvial deposits:—"By the word of God the heavens were of old, and the earth standing out of the water and in the water, whereby (that is, by which heavens) the world that then was, being overflowed with water, perished."

Such is the testimony of Moses and the Apostle Peter.

What says geology? While I am writing, a voice is heard from the mountains on the other side the broad Atlantic, attesting the truth of the Biblical record. I quote the following paragraph from the 'London Journal,' March 19, 1864:—

"*The Earth made Cold by Heat.*—Professor Agassiz lately delivered a course of three lectures in Boston, U.S., and the greater part of the last one was devoted to a description of the phenomena which indicate that the continent of North America had at one time been overlaid by dense and unbroken masses of ice, moving from the north to the south. The traces of such an agency are found in the peculiar drift deposited on the surface of the continent, from the Arctic to the 36th or 40th parallel of latitude, being in its nature and composition such as would be deposited by immense cakes of ice, pushing forward the débris of the soil over which they moved, and bearing on their top the irregular masses of stone which are found in the region designated. That the direction of this moving mass of ice was from north to south is proved by the abrasion of hills having an acclivity facing towards the north, where the southern descent is without such characteristic marks. After stating the grounds on which the 'earthquake theory' was inadequate to explain the phenomena of this drift, Professor Agassiz estimated that the ice which deposited this drift and produced its other attendant phenomena must have been 5000 or 6000 feet thick. But whence came the cold which produced such a thickness of ice? This query was answered by supposing that there had been injected into the sea, from the subterranean fires of the earth below it, a vast mass of melted material, thus producing an immense volume of vapour, which, escaping for ages into the upper air, was condensed, and fell in the shape of snow and hail. By this mass of snow and hail the temperature of the earth's climate was reduced from the comparative warmth which preceded it, even in Arctic regions, and the world entered on '*the cold period*,' which it was the object of the lecturer to describe and to account for while describing. Professor Agassiz said that *this was the winter which preceded man's advent in the world*."

Is not my point made out? Is not the *thoku* and *vohu* of Moses identical with *the cold period*, *the winter of the world*, of Agassiz? Surely there can be only one answer.

It seems almost superfluous to refer to the boulders which are found in Norway and on the coasts of north-western Europe, which evidently belong to the period of the Drift, and which have been borne to the spots where they are now found on moving ice.

I think, Sir, your readers must allow that my point is clearly made out, namely, that Moses and the geologists are of one mind as to the deplorable condition of the earth at the time when the Mosaic record and geology come in contact. I have the honour to remain, Sir,

Your obedient servant,

FREDERICK FYSH.

Walgrave, April 7, 1864.

P.S. I take the meaning of the fourth day's creation to be, that the sun, moon, and stars, which had been previously obscured, then became visible. Henceforth the earth was to receive light from those luminaries, and not to be supplied with miraculous light, as on the first day.

The Scottish Pteraspis.

Dear Sir,—If not occupying too much space, I would feel obliged by your inserting in an early number the following remarks on the communications in your numbers for March and April from the Rev. H. Mitchell and Mr. E. R. Lankester; these I have the less hesitation in offering, as, while fully appreciating the value of the criticisms of one who has done so much towards adding to our knowledge of this genus as Mr. Lankester, I can at same time fully corroborate the correctness of Mr. Mitchell's restoration, in his interesting letter, in almost every particular.

In a former letter (Geol. Feb. 1863) I had occasion to remark that Mr. Lankester, in a notice (Dec. 1862) of a former and much less correct restoration of our Scottish Pteraspis by Mr. Mitchell (Nov. 1862), had not made sufficient allowance for probable specific difference of form. I must here state my belief that the same mistake has again occasioned some of Mr. Lankester's remarks in his last letter. I had recently an opportunity of inspecting Mr. Mitchell's series of specimens of this fish, and of comparing them with my own. They all undoubtedly belong to the same species, and are in my opinion distinct from *Pteraspis rostratus* and other English species.

The only points in Mr. Mitchell's latter restoration which appear to me scarcely correct are, that the breadth seems rather exaggerated, and that the posterior margin is represented as formed of straight lines, while it consists of a double curve, concave posteriorly. The lateral posterior angles are produced, forming well-marked but very short cusps, pointing backward and slightly outwards. From this and also from the well-marked and finished lateral outline of the posterior head-plate, I think it extremely improbable that this species ever possessed the lateral small plates forming the cornua of *Pteraspis rostratus;* certainly none of the many fragments in our collections show any vestige of these. One of my specimens has the occipital spine *in situ*, and in several of Mr. Mitchell's the spine is shown detached; thus differing from the occipital crest of Cephalaspis, which forms an integral portion of the head plate. This spine is short, stout, striated longitudinally, and is deeply inserted in the substance of the head plate, in which it seems to have been inmovably fixed. In their composition the head-plates are quite similar to that of the English species, some of Mr. Mitchell's specimens having, as noticed by him, the exterior striation, the internal reticulated markings, and the inner nacreous plates or lamellæ well preserved. From his specimens I have little doubt that the perforations at *b*, in the figure given in your number for March last, are indeed the eye orbits; while those at *a* are too distinctly marked to have been the result of accidental fracture, whatever may have been their nature. As drawn in Mr. Mitchell's latter restoration, and in my figure (Geol. Feb. 1863), the test consists of only two distinct plates, an anterior and posterior, with a distinct spine.

No light has yet been thrown on the nature of the under surface of the head, some of our many fragments may possibly belong to this part of its body; to me, however, they all seem mere broken fragments of the upper cephalic plates.

As to the oral appendages, until very recently I was of opinion that these were of the nature indicated in Mr. Lankester's letter, both in this genus and in Cephalaspis. This opinion was founded not only on negative evidence, but also on the form of the plate protecting the under surface of the head of the latter genus, and in my letter referred to (Feb. 1863) I expressed this conviction pretty strongly. During the course of last autumn, however, I had the good fortune to open out some magnificent specimens of *Cephalaspis Lyelli*, in which the position and character of the mouth and teeth are distinctly exhibited. The mouth opened immediately under the cephalic plate, the gape occupying about one-third of the entire outer margin, the upper maxillæ, or jaws, anchylosed with the cephalic plate, forming an integral part of it, and are finished with a single row of short, stout, slightly flattened teeth, which extend quite round to the cornua or cusps. In one of my specimens, a portion of the lower jaw is preserved with its single row of similar teeth. From the decided analogy between Cephalaspis and Pteraspis, it is probable that the latter had been similarly provided. One of Mr. Mitchell's specimens seems to bear this out, having, as noticed by him, the anterior margin of the anterior plate turned downwards and inwards, as in all our moderately well preserved heads of Cephalaspis. The analogy between these genera is further confirmed by Mr. Lankester's most interesting discovery of the scales of Pteraspis, stated by him to be similar to the dorsal series of Cephalaspis,—meaning, I presume, the bony rings covering the body of this creature. These, however, my specimens show to have been again covered externally by scales similar to those covering the cephalic plate.

It seems to me that as yet the nature of the Cephalaspidæ is very imperfectly understood. I strongly suspect the cephalic plate to consist of the various cranial bones anchylosed, while the bony rings protecting the body equally appear to represent the vertebræ and ribs; all covered externally with scales, or rather dermal scutes, thus indicating that this family may have held among the fishes a place somewhat, although by no means exactly analogous to that held by the Chelonians amongst the more highly organized reptiles. Much careful investigation is necessary, and still more perfect specimens are required before this can be fully wrought out.

It is right here also to state that to Mr. Mitchell belongs the merit of first discovering Pteraspis in our Scottish rocks, although it is only very recently that I was aware that he had procured and recognized fragments of this fish some time anterior to my discovery of its remains. Believing our Scottish Pteraspis to be specifically distinct from the other species yet found, in a paper which I hope to have the honour of communicating at an early meeting of the Geological Society of London, noticing it along with some other Forfarshire fishes, I propose his name as a specific affix for it, and that it should be known as *Pteraspis Mitchelli*.

I am, dear Sir, Yours ever truly,
JAMES POWRIE.

Reswalla, April, 1864.

Spiral Planetary Orbits.

Sir,—Your highly suggestive article on "Spiral Planetary Orbits" (*vide* 'Geologist' for March) gave rise to some ideas which may prove interesting to those of your readers who are partial to speculative inquiries.

The generally accepted explanation of the planets' translatory motion is, that those bodies were projected *once for all* into free space with great velocity, and that as they meet with no resistance they will always continue their course.

The existence of free space here assumed, is, however, very doubtful, since we can hardly reconcile a perfect vacuum with the transmission through it of light and heat, for we know of no such thing as physical force existing independently of matter. But, as you have already shown, if matter does occupy space, then, however rarefied it may be, there must be resistance, friction, and consequently retardation of planetary motion. This slackening of the speed, by destroying the equilibrium of the centripetal and centrifugal forces, would contract the orbits, and ultimately cause the planets to fall into the sun. The equilibrium of the two forces once destroyed, both the decrease of speed and the increase of attraction would tend to the same end, and the motion towards the sun would be so continuously and immensely accelerated that the final catastrophe would not perhaps be so far distant as might at first be imagined.

To such a view of planets revolving in a plenum, without any supply of motive force but that first acquired, some difficulties present themselves, not the least of which is, that if the results of retarded planetary movements are expected to evince themselves in the future, they may also be looked for at present, as phenomena indicative of such retarded movements during time past; for we know not, neither can we imagine, what proportion the past bears to the future.

But can we discern any such phenomena? Not in the planetary circuits, for the centripetal and centrifugal forces still appear to balance each other, their equilibrium remains undisturbed, and we do not find that those planets nearer the sun have a decreased orbital velocity. On the contrary, for "the angular velocity of a planet's movement in its circuit is inversely as the square of its distance from the sun."

How, then, can we reconcile the continued regularity of planetary motion with the existence of a resisting medium in space? Does it not appear as though we should have to discard the "projected once for all" hypothesis, and assume the existence of a sustained or continually acting motive power?

Then, recalling to mind the correlation of the physical forces, and viewing heat and the other forces as directly or indirectly convertible into their equivalents of motion, we are induced to ask, may not force emanating from the sun be the sustaining cause of planetary centrifugal motion? Here we should have a continuous supply of force, which, by counteracting the centripetal force and the resistance of ether, would prevent any contraction of the orbits. Moreover, by such means, we could understand how it is that planets nearer the sun have a greater velocity than those more distant, for the increase of heat and consequently of velocity they received would be equal to the increase of attraction, and heat, velocity, and attraction would all be inversely as the square of the distance of the body from the sun. This we find to be the case.

According to such a view, our journey around the sun would only cease when that luminary failed to supply the necessary amount of force. But, were the sun to become dark and cold, no life could exist on our globe, no changes could take place in the conditions of matter, there could be no liquids, no gases, so that the contact of earth and sun at such a time would be the collision of two dark, gloomy, silent, lifeless masses of inert matter.

The revolution of satellites around planets, as for example that of the moon around the earth, might perhaps be accounted for by supposing the earth's motion (which we cannot believe to be wasted), converted into frictional heat at the surface, which, together with the moon's heat, might act as sufficient centrifugal force to counteract their mutual attraction. The moon's revolution, in conjunction with the earth, around the sun would be perhaps the result of that luminary's heat or force acting on planet and satellite as a connected system.

The greatest difficulty which presents itself to the view of solar force producing motion is the fact that we only know heat as a molecular force. But M. Faye, in the 'Comptes Rendus,' supposes the existence of a repulsive force exerted by the sun, not to be expressed by attraction with a negative sign prefixed, but bearing the same relation to molecular repulsion as celestial attraction does to terrestrial attraction.

Lastly, let us call the comets into the witness-box, and see what those eccentric individuals have to say on this subject. In an article entitled "Cometary Phenomena" ('Intellectual Observer,' 1863), we find the following:—"It is evident that the whole of the mass is vehemently acted upon by some influence emanating from the sun, the continuation and accumulation of which, after the perihelion passage, seem to point to a calorific rather than a more instantaneous electric or magnetic action." Again, Mr. Marsh, in writing of comets in the 'American Journal of Science and Arts,' attributes the peculiar character of cometary matter to the extreme and violent changes which it undergoes in its rotation around the sun. Halley's comet, for example, at one time approaches the sun to within 56 millions of miles, and then recedes to the enormous distance of 3370 millions of miles. At the time of its perihelion, or least distance, it passes through one heliocentric degree of its orbit in 15·7 hours, and receives in a given time 3600 times as much heat as when it reaches its aphelion or greatest distance, in which position its motion is so slow, that six years and a half are required for its passage through one heliocentric degree. Thus, it will be seen, that comets with eccentric orbits are subject to violent changes of temperature and velocity which do not affect (to such an extent) planets whose orbits approximate more closely to the circular form.

In conclusion, it may be said that in the absence of a continuous supply of motive force, it is quite as difficult to reconcile a plenum with planetary regularity as a vacuum with the transmission of light and heat.

I am, Sir, yours obediently,
JOHN PENTECOST, F.C.S.

London, April 6, 1864.

COLONIAL GEOLOGY.

LEAVES FROM MY AUSTRALIAN NOTEBOOK.

BY THOMAS HARRISON, OF MELBOURNE.

NO. I.—CAPE SCHANCK, ITS BASALTS AND CAVES.

This spot, although barely, as the crow flies, fifty miles from Melbourne, is not easy of access. Its bold, precipitous, and iron-bound coast-line offers no harbours; the district boasts of neither town nor township—an Australian name for a little village, just as a city in America may mean half-a-dozen tenements,—a few farmers till the rich soil of the neighbourhood, and some three or four squatters have stations thereabouts; the traffic between such a place and the metropolis is small, and on its not altogether bad roads coaches are unknown. To proceed thither one must take his own or hired horse or vehicle, or he must go on foot. Adopting the latter alternative, the better plan will be to land at Schnapper Point or, supposing the steamer should be running, at Dromana. This, the last township on the route, is composed of some two or three houses, as many hotels, and a long pier, built apparently to accommodate the latter. Close adjacent, and the principal landmark near, is Arthur's Seat, a hill or mountain of some thousand feet in altitude. This consists of a central granite mass, surrounded by Tertiary, Silurian, and Basaltic rocks. The ascent is easy and the height by no means great, but being situate on a sort of peninsula, the view from the mountain top is extremely fine, embracing, as it does. an extensive panorama of Western Port, Port Phillip, Bass Straits, and in one direction the vast spread of still uncleared land lying between the seacoast and the Australian Alps.

In visiting the spot I was unable, during the short time at my disposal, to detect traces of the Tertiary deposits having been in the least disturbed, so that, although the surface of the adjoining district appears to have been alternately raised and submerged several times, the changes must have been brought about by movements in which the older granite and the newer strata alike participated. Descending from the mountain, the road lies for some miles further along the coast of the adjacent bay. In this part of the journey very little of the picturesque presents itself, the student of geology may, however, see in some measure how rocks are formed, by a careful contemplation of the numerous sandbanks running along the shore; and may, moreover, chance to find, stranded upon the beach, more than one specimen of that representative of a bygone age, so interesting to the student of oolitic and cretaceous fossils, the *Cestracion Philipsi.*

Leaving the beach, in order to cross the peninsula at its narrowest part, the bush track to be followed leads over an extensive limestone district and an immense number of little hills, called locally "cups and saucers,"—a name derived from each hillock resembling a sort of rounded cup or basin turned upside down. A more tame or dreary bit of scenery can scarcely be imagined. In the valleys it is impossible to see twenty yards before you, and on the higher portions of the ground you see nothing but the eternal round-topped hills, each so like its fellows, that, supposing the sun does not shine, one is certain to lose his bearings unless the compass is constantly studied. What trees there are appear stunted and deformed, and in summer the scrub below is either parched up by heat or blackened by bush-fires. Ever and anon you come across a dilapidated hut, used, in the days of building speculation or a dearth of coals, as the abode of either a lime-burner or a wood-cutter; but there is nothing very pleasing in the spectacle. Of streams of water there are none, although springs are said to be readily found at a very moderate depth. Being once lost hereabout for eight hours, with an empty pocket-flask, an unpleasant reminiscence of a recent breakfast on salt meat, and beneath the parching sun of an Australian summer, I have a most vivid recollection of the locality, and the particular joy experienced when, like the soldiers of the old Grecian general, I was able to cry, "The sea! the sea!" and survey from the last dry "cup and saucer" of the set or series the fine spectacle of Bass Straits rolling its giant waves lazily on the beach.

The first thing striking the tourist on the Straits side of the peninsula is the number of sand dunes everywhere apparent. These are still in process of formation, stretching with a gentle slope towards the sea, presenting a tolerably steep escarpment inland, looking the very pictures of desolation, bare as they are of all herbage, save where a few sand-reeds have taken root, or where some already half-buried tree stretches its few leaf-covered branches above the drifting sand.

The limestone hereabout is remarkable for containing numerous concretions shaped like branches and roots. Settlers in the neighbourhood declare these to be petrified trees, long since buried as before described; a belief in some degree borne out by the large number of trees seen to be, more or less, completely covered up in all directions by the ever-moving hills. Certainly the resemblance to petrified trees is exceedingly great, and down the centre of more than one of these bodies I have myself found running a small portion of decaying wood; so that if the ligneous substance does not actually petrify, it may act as a sort of conductor, whereby water is guided through the mass, cementing, in time, the grains of sand and comminuted shells into a stone harder than the surrounding rock.

The wide extent of sandy beach and the friable nature of the limestone is hardly favourable to the development of very precipitous cliffs, and generally, even where the coast is highest, the ground slopes with tolerably steep descent towards the sea. After a time, however, a singular change in the cliff formation is apparent. A jutting headland is distinctly seen, in the distance, presenting its lowermost and basement stratum to the waves as a straight and perpendicular wall of rock, whilst higher up there is the formerly observed sloping portion, the whole looking somewhat like the edge of a plank bevelled to the extent of half its thickness. This appearance is the natural result of the lower portion being basalt and the upper being limestone, similar to that before described. This cliff, composed of these two strata, rises in some places to nearly two hundred feet. Cape Schanck itself, a projecting tongue of land, is nearly of this altitude, and is surmounted by a lighthouse bearing its name, and towering upwards for another fifty feet.

Generally speaking, the cliffs are nearly impracticable for either ascending or descending, but immediately eastward of the Lighthouse Point the basalt suddenly dips, and the bottom of the limestone being but little above the sea-level, a slope is formed, by means of which descent is a matter of but little difficulty; scrambling down this, the spectator finds himself in a little cove—dry, save during storms from the south-west—and which, from its cindery appearance, might be a sort of vestibule to Tartarus. At one place, where the cliffs are most perpendicular, is seen a small opening, which, explored, turns out to be the entrance to a cave, from whose roof depend immense stalactites of fantastic forms. It often happens that caves in volcanic rocks are the result of a fault, consequent on two streams of molten matter meeting and forming an imperfect joint; but the cave under consideration apparently owes its origin to a soft strata of basalt (presently to be alluded to), which being eaten away by successive tempests and the percolation of land-springs, has left the cavity as at present. The stalactites are simply a deposition of lime gathered by water gradually filtering through the limestone stratum by which the cliffs are surmounted hereabout.

The force of water driven into waves by continued storms may be studied here with great advantage. Looking out from this solitary inlet, as sea after sea comes tumbling in, the scene is grand in the extreme. Rocks such as Martin loved to paint as foregrounds to his pictures, are here seen, alternately white with foam or black as some huge sea-monster shaking his dripping sides above the brine. Nor is the beautiful absent in this sequestered spot. In sheltered nooks sea-anemones spread out their flower-like tentacles, and troops of tiny, brightly-painted mollusca crawl lazily over the sea-washed boulders. Adown in crystal pools, left by the retreating tide, appears a bottom thickly covered with seaweeds of a hundred hues. Looking at these, one starts, perhaps from their propriety, a body of migratory crabs, who take tremendous "headers" downward into the limpid water, and hide in sore affright mid groves of fucoids.

Just out at sea, beyond the slanting tongue of limestone by which the descent has been made, stands a solitary pillar of basalt fifty feet in height, and known as the pulpit rock. In these days of iron-clads and cupola-ships, looking at the mass from one point, it is not difficult to associate its peculiar form with that of a huge, half-submerged battery with a single turret. The mass of limestone, too, close adjacent, bears no slight resemblance to the iron-roofed 'Merrimac.' Seen together, these two objects might reasonably be taken for the 'Monitor' and her famed antagonist, which, meeting in deadly strife, were going down head first beneath the billows.

Along the whole range of coast from the above spot to Western Head are scattered evidences of phenomena interesting to the geologist. In one spot a spring, after percolating the limestone rock and bubbling out from beneath the foot of the cliff, coats the shingle with calcareous sinter, and forms a conglomerate of basaltic pebbles, shells, and corals; in another, masses of seaweed drifting ashore with stones entangled in their roots, show how portions of a distant rock may be transported and eventually dropped on some deep sea-bottom where currents are unknown. Here there are caves large enough to hold a hundred smugglers, and close beyond a natural arch that might have been built by gigantic Titans; a little further, and there is a basaltic stack rivalling a cathedral in dimensions, or a lofty pillar, poised on a slender base, rears itself in some sheltered bay.

Near Western-Port entrance, the basalt dips downwards into a sort of basin, in which a whitish Tertiary rock, looking at a distance like chalk, but very different in appearance from that rock when closely examined, has been deposited, and is literally built up of spines of Echinidæ, shells of mollusca, and the broken carapaces of large crustaceans. The whole of these remains, with the exception of the spines, are much broken; the latter are so well preserved that youths in the neighbourhood collect them to use as slate-pencils: for such a purpose they answer most admirably.

About a mile westerly from this rock, the upper portion of the basalt having been denuded down to the water's edge, a pavement of hexagonal and pentagonal blocks is displayed. These, the blocks, are of such regularity as to resemble a work of art rather than one of nature. Here, as in most portions of the district along the coast, the basalt is arranged in a manner which resembles stratification. First of all, at the sea-level, or near it, is a compact rock, sometimes columnar, although from its low level this feature is not particularly noticeable, unless, as in the case above cited, the ends of the columns are laid bare; next there is a thin bed of red-ochrish clay, comparatively soft and friable; and above, forming the summit of the cliffs, save where the limestone appears as a capping, is a thick mass of basalt, only rudely, if at all of a columnar structure.

No idea can be formed of the extent downwards of this lower bed, it never having been passed through. The thickness must, however, be considerable, since basalt only assumes a crystalline form when collected and cooled in large masses.

As a rough guess, I would suggest that the entire formation is the result of at least two outbursts of molten material, and that the clayey stratum referred to had collected either as scum and scoriæ arising from the molten matter, or as detritus deposited thereon by aqueous agency. Over this the upper basalt was afterwards poured out. Subsequently the district sunk beneath the sea, allowing Tertiary rocks, after covering the whole, to be deposited; last of all, the formation was raised to its present level, and the process of denudation commenced.

This denudation would be greatly facilitated by the existence of the soft layer just referred to. On this the waves, as they do at present in eating out caves and arches, would act successfully. Once undermined to any great extent, the fall of large portions of cliff would be a matter of certainty, and strewn upon the beach as boulders and shingle kept in motion by successive surges, every fragment would act the part of a muller grinding and being ground to powder; thus the talus would be cleared away, and the sea would be permitted once more to eat away the soft and yielding stratum.

Reflecting upon these phenomena, the mind is naturally astonished at the idea of a sea of molten materials stretching over an area of fully two hundred square miles. Nor is the subsequent wasting away and denudation by waves and ocean currents, to the extent which becomes evident by a merely casual observation, one whit less startling. Basalt similar in mineralogical character, and of like geologic age, forms the surface-rock of Philip, is covered by a thin capping of Tertiary deposits in French Island, and overlies the Carboniferous strata on the adjoining mainland near Griffith Point. No one examining these several basaltic masses can doubt of their having been once continuous. The various channels leading to the ocean, together with the greater part of Western Port Bay itself, must have been literally cut out by the continual influx and eflux of the tidal wave. Some of the difficulty may be avoided by supposing a soft strata undermined by the huge breakers of the Pacific, as previously alluded to, but even then the time necessary for accomplishing the required result almost surpasses belief. Shingle in every stage of formation from fine sand to angular boulders, huge landslips whose fall must assuredly have been of comparatively recent date, and rocky masses so undermined as to render their speedy crumbling into a mass of detritus a matter of certainty,—all point to the same conclusion, that the disintegration of the indurate material has been solely the result of aqueous agencies long continued. Still, both theory and fact alike declare the immensity of the period required to bring about the changes witnessed. The colonist remembers the shingly beach as ever shingle; the mass of talus seems to have undergone no visible change; and the rocks, whose bases are undermined, and whose stability thus seemingly destroyed, appeared just as near their dissolution when some adventurous circumnavigator left his vessel in the offing, and landed hereabout for the first time some century ago.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

SCHOOL OF MINES.—DR. PERCY'S LECTURES ON CHEMICAL GEOLOGY.

LECTURE III., *December* 17, 1863.—At our last meeting attention was especially directed to the subject of alumina, a base consisting of a metal termed "aluminium" and of oxygen. It exists extensively diffused through nature, and is the essential constituent of all clays, or, at all events, is *an* essential constituent of all clays. It exists in nature beautifully crystallized, and is then known as corundum. When coloured blue it is termed sapphire, when red, ruby. Sometimes this corundum occurs opaque from the presence of impurities, and then we have it in the form of common emery. In the laboratory of the chemist, dried alumina is known simply as a white amorphous powder, excessively insoluble and infusible. Having described the physical and chemical properties of alumina, we proceeded then to examine certain methods by which it can be obtained in a crystalline form. We will now pass on to consider further this part of our subject.

In the first place, the lecturer claimed attention to a singular and beautiful mineral "staurolite," which has been prepared artificially. A word by way of caution. It does not follow that the methods by which we can prepare mineral matters crystallized in the laboratory, should be precisely those which nature herself has adopted on a great scale, though in many cases there is no doubt that the processes employed are really identical with those which nature herself has employed. Then, again, there is another very important point to bear in mind. The same mineral substance may be produced by methods entirely distinct. The well-known and beautiful mineral termed "felspar" can be produced both by the agency of liquids at a tolerably high temperature, and also directly by igneous fusion. Specimens of magnificently crystallized felspar have been taken from furnaces, where there is no doubt about the mode of its production. And now for this mineral, staurolite, which is a silicate of alumina. We are indebted to Deville for a singular experiment regarding the formation of this mineral. It does not at all follow that his process should be exactly that which nature herself has adopted, but still it is remarkably illustrative of what may occur, and on that account is worthy of notice in detail. We take a porcelain tube, and place it vertically in a furnace. It is open at both ends, and we introduce through the upper part of the tube the gas, fluoride of silicon. At the top we have a layer of alumina; then there is a layer of silica; and so on in alternation—alumina, silica, alumina, silica—beginning with alumina, and finishing with silica. We will heat that tube to red-whiteness, and then note the result. The gas, fluoride of silicon, is a compound of fluorine and silicon. When it comes in contact with the alumina, a curious reaction takes place. A portion of the silica is deposited here, and we get the mineral silicate of alumina, a corresponding proportion of the aluminium displaced and volatilized in the form of fluoride of aluminium. It is important clearly to understand this part of the operation. You perceive that we bring fluoride of silicon in contact with alumina, that is, with a compound of aluminium and oxygen. A reaction takes place between those two substances at this temperature, whereby silicate of alumina is produced. The mineral, staurolite, happens to be this particular silicate of alumina, and fluoride of aluminium is evolved. That descending, and coming in contact with the stratum of silica beneath, undergoes a change similar to that which the fluoride of silicon underwent in the first instance, and we get the same mineral formed in the second layer from silica as was formed in the first layer from alumina—in one instance by the action of fluoride of silicon, and in the other by the action of fluoride of aluminium. At the second decomposition there is fluoride of silicon evolved, which acts upon the aluminium below exactly as in the first instance; and so it goes on in succession, and at length you obtain the tube full of the mineral staurolite—this silicate of alumina, and yet you have only employed a small amount of fluoride of silicon in the first instance to effect this transformation. Thus, by a small amount of this body, you can convert an indefinite quantity of alumina and silica into this mineral. As much fluoride of silicon finally escapes from the tube as entered it in the first instance. It is one of the most beautiful and striking experiments in the whole of this department of science. The staurolite produced in this way is crystallized.

We pass on to a few remarks on another curious and important mineral,—namely, topaz. This is a compound, the precise rational composition of which does not appear to be very clearly understood even at the present time. It is essentially a silicate of alumina containing fluorine, but some doubt is entertained as to the exact mode in which that fluorine exists in the compound.

Now, one might have reasonably anticipated that topaz might have been produced in some such way as that just explained with regard to the production of staurolite; but, according to Deville, who tried the experiment, topaz cannot be so formed. There is, however, some little discrepancy in the statements which have been made on this point; for Daubrée states that it is formed by heating alumina to redness in a current of fluoride of silicon. We must wait for further information, seeing that these two chemists disagree on the subject. But if topaz cannot be so formed, a peculiar mineral termed "zircon," which is a silicate of zirconia (zirconia corresponding in formula with alumina), may be produced in beautiful crystals when the fluoride of silicon is passed over zirconia. Take a tube containing zirconia, and heat it to a good red-heat, or more than that, and then pass over the gas fluoride of silicon, and you obtain the mineral crystallized

—a silicate of zirconia. It occurs, Deville says, in octahedral crystals, and these crystals exactly resemble those of Monte Somma, in Vesuvius. He assures us that they have the same faces, the same angles, and the same external characteristics; so that he concludes that it is almost certain that they must have resulted from the same process—from the same operation of fire. Every mineralogist knows that certain specific minerals have peculiarities according to the locality, and these must depend upon certain conditions attending their formation. Now, as these crystals of zircon possess such an assemblage of characteristics, we may reasonably admit that Deville's conclusion has something like a good foundation to rest upon. Then he further remarks, it may be demonstrated that the small quantities of fluor existing in the metamorphic rocks, or rather beds of this kind, have sufficed to form indefinite quantities of zircon. We shall, by-and-by, direct attention to the subject of fluor, which may have played a very important part in the economy of nature,—a much more important part than many persons are yet disposed to admit. It is, as we shall see, a very widely-diffused element, though occurring only in small quantity.

When the same experiment was made entirely with zirconia instead of alumina, the whole contents of the tube were completely transformed into zircon. Zircon occurs in rocks which, there is reason to believe, have been exposed to a tolerably high temperature. It occurs in the syenite of Norway, for example, replacing felspar; so that the rock consists only of hornblende, zircon, and a small quantity of quartz; hence the rock is designated "zircon-syenite."

The next mineral which it may be interesting to examine is the mineral termed "cryolite," which, in fact, forms a geological bed. It is an exceedingly remarkable mineral, fusible at a comparatively low temperature. It is a compound of fluoride of sodium and fluoride of aluminium. Its formula is $3NaFl + Al_2Fl_3$. It is an anhydrous mineral—that is, free from water. It contains about 13 per cent. of aluminium. It is found in Greenland in a layer of gneiss, and in the vicinity of mica. According to Bischoff, there is a quantity of mica about it, which he supposes has played a very important part. The bed of cryolite is eighteen feet thick. Cryolite is associated with various minerals which undoubtedly are of aqueous origin. For example, iron pyrites—though certainly not prepared at a high temperature—copper pyrites, galena, and sparry iron ore, which certainly never could have occurred at a high temperature,—these are the associates of cryolite, and they tell us the story of its formation. It is clearly produced by the agency of water as a solvent. It may be produced by melting together directly fluoride of aluminium and fluoride of sodium. It may also be formed in the wet way by digesting fluoride of sodium with excess of hydrochloric acid and common gelatinous alumina.

Bischoff supposes mica to have played a very important part as a source of fluorine,—indeed, as a source of fluorine in common fluor spar which we meet with in so many localities.

The next subject for our consideration is one of considerable importance—of the highest importance; it is that of calcium and lime.

All lime, like alumina, contains a metallic base. Calcium, the base of lime, is exceedingly light, has a yellowish colour, is readily fusible, and exceedingly oxidizable, so that it is impossible to expose it to the air without its undergoing oxidation—contrary to what we have seen is the case with aluminium. Recently, some important experiments have been made by Wöhler on the subject. He has discovered certain combinations of carbon and calcium equivalent to those known in iron—in the form of pig iron.

It is with lime especially, and its compounds, that we have to do. Lime is composed of one equivalent of calcium and one of oxygen. You are all familiar with the properties of lime—an amorphous body, white, or more or less coloured with impurity, and which, on the application of water, slacks; that is, it absorbs water, the water enters into combination with it, and becomes solid, and on its passing from the liquid to the solid state, a large amount of heat is evolved. The lime falls to pieces, having become hydrated, or, in common language, slacked. It is slightly soluble in water, as every one knows, producing the well-known liquid called lime-water. When combined with water—for it must be hydrated—it unites readily with carbonic acid, forming carbonate of lime.

Carbonate of lime is a mineral which occurs very extensively in nature, forming beds of chalk, limestone, and two very important minerals, namely, calcite and arragonite. Carbonate of lime is a compound of one equivalent of carbonic acid and one of lime. It is known in three distinct states. There is, first, the amorphous or chalk-like state: we will call it chalk. It is perfectly non-crystalline or amorphous. There is, then, the form of arragonite which occurs in prismatic crystals, and belongs to the prismatic system. The third form of carbonate of lime is that of calcite or calcspar, which is rhombohedral, crystallizing in the beautiful rhombohedral crystals with which every mineralogist is familiar. Arragonite varies in specific gravity from 2·93 to 3·01. This is a point to note. The calcite has a lower specific gravity, ranging from 2·69 to 2·75, so that not only in their crystalline system, but also in specific gravity, are these two minerals distinguished clearly from each other.

The next point is the solubility of carbonate of lime. In treating this subject of chemical geology, the lecturer was selecting all those points which he conceived had a direct geological bearing; and it is requisite to pay rather close attention, which, perhaps, may be considered tedious, to this part of our subject. One part of carbonate of lime dissolves in 110,000 parts of pure water, in round numbers: it is 110,132 parts really. This carbonate of lime dissolves to a much greater extent when carbonic acid is passed through the water, and it then forms what is termed bicarbonate of lime. One part of carbonate of lime dissolves in 998 parts of water containing carbonic acid, according to Bischoff, the carbonic acid being passed through the water for an hour. He has made several experiments upon this subject, which are remarkable. He finds that the solubility varies to a great extent with the nature of the carbonate of lime operated upon. Thus, 11·15 parts of chalk were dissolved in 10,000 parts of water by passing carbonic acid through for an hour. He performed this experiment three times, and each time he obtained pretty nearly the same result; but, when he tried the experiment with carbonate of lime precipitated from a salt of lime, passing the carbonic acid through for about the same time as he did in the experiments with the chalk, he found that 28 parts dissolved in 10,000 parts of water. There is another very striking statement, but which will require further corroboration. It is, that burnt muschelkalk dissolved to the extent of 135·3 parts in 10,000 parts of water, by passing carbonic acid through the water for an hour and a half.

In passing, he would mention the fact, that when arragonite is exposed to a red-heat, it falls to powder; and it was supposed for a long time that this powder consisted of minute rhombs of calcite. This, however, is denied by Gustave Rose, who contends that the powder is strictly amorphous.

Let us now consider the mode of formation of arragonite, or the conditions under which it may be produced; and, when we understand these conditions, we shall find that the information afforded will tend to elucidate the formation of certain geological phenomena, especially with reference to temperature. It will indicate to us the temperature and other conditions under which rocks containing arragonite may have been formed.

Arragonite may be formed by dropping common chloride of calcium in molten carbonate of potash or soda. The method is to melt the carbonate, and then drop in the chloride of calcium. Decomposition occurs, and chloride of potassium or sodium and carbonate of lime are formed. We owe to Gustave Rose several experiments upon this subject, which, though they may seem somewhat minute and tedious, are extremely important and interesting. In the molten state the mass is clear, but it becomes opaque and white on solidification. Upon washing the product with cold water, an amorphous carbonate of lime or chalk was produced. It was always obtained at first in minute microscopic globules, perfectly amorphous, or non-crystalline; but Rose tells us that after twenty-four hours the whole became changed into rhombic crystals of calcspar. That is a curious point, and the lecturer asked particular attention to the temperature of the water employed, and the degree of dilution, for all depended upon those two conditions. On the other hand, by boiling the product in water, instead of washing it with cold water, the globules are almost instantly changed, not into rhombs of calcspar, but into prisms of arragonite. This little difference of temperature, then, is sufficient to effect this great change. These microscopic crystals of arragonite being left to cool in the water, become transformed into rhombs of calcite. He found that the same results were obtained by substituting chalk, arragonite powder, or calcspar, for chloride of calcium. Some experiments on this subject were made a long time ago by Becquerel, to whom we are deeply indebted for a great variety of experiments bearing on the subject of mineralogy. He was one of the first to take up the subject energetically. He formed arragonite by leaving plates of selenite or gypsum during several years in contact with a solution of bicarbonate of soda of the specific gravity of 1·070. The result of the decomposition was sulphate of soda and carbonate of line. The carbonate of lime produced appeared in the form of crystallized arragonite. The crystals consisted of very acute double pyramids, base to base, thus producing a very acute dodecahedron. The same result was obtained in a few days by heating to the boiling-point (100° C.) plates of selenite in a solution of bicarbonate of soda, saturated cold. The solution was contained in hermetically-sealed tubes of glass, and great pressure was given by a very ingenious artifice. There was no necessity in this case for raising the temperature of the glass very high to get the pressure. The pressure required was about five atmospheres, and this was obtained by half filling the glass with the solution in question, and then putting in a few drops of bisulphide of carbon, which is an exceedingly volatile body. It was inert, having no effect whatever upon the solution, but it enabled him to get a pressure of five atmospheres at this low temperature. He tells us that the crystals of arragonite which he thus formed were very distinct and very limpid, and in ten days they were $\frac{4}{100}$ths of an inch on the side.

These various points are apparently trivial, but in their application they may be of considerable importance, as what appear to be small things very often are. Gustave Rose found that, by leaving a very dilute aqueous solution of carbonate of lime in excess of carbonic acid, freely exposed to the air, arragonite was formed. All depends upon the solution being very dilute and at the ordinary temperature. If a common solution of carbonate of lime in excess of carbonic acid is thus left exposed, you will get, not arragonite, but crystals of calcite. This is a remarkable fact. By heating a common solution of carbonate of lime—that is, a solution containing the ordinary amount of carbonate of lime dissolved by virtue of the presence of carbonic acid—you get arragonite, and not calcite. An ordinary solution of carbonate of lime, or—what is equivalent—a much stronger one, gives calcite by exposure at the ordinary temperature; and this same solution, when heated, deposits arragonite. If such a solution be evaporated in a platinum vessel, the residue contains carbonate of lime in all three forms, namely, the amorphous or chalk, arragonite, and calcspar. This is an important point.

Having obtained these results, Rose then went on to investigate the precise changes corresponding to different degrees of temperature. These are his chief results:—At 100 Centigrade—that is, the boiling-point of water—the greatest part of the residue was arragonite in characteristic small prisms. At 90° the most arragonite was formed, and the crystals were larger than at other temperatures. At 70° the rhombic crystals of calcspar predominated, and were accompanied by hexagonal plates and small stars of calcspar, and the arragonite crystals were small. At 50° there was more calcspar, and the proportion of plates and stars, as compared with the rhombs of calcspar, increased. The arragonite crystals were thicker, and often bent or curved. At 30° no arragonite whatever was formed. The rhombic crystals of calcspar were comparatively large, and there were still some plates and stars. It is very remarkable that he should get these varieties of deposit under these different degrees of temperature and solution. All the arragonite occurred at a higher temperature than 30°, and the hexagonal plates of calcspar were formed at a lower temperature than 70°. Calcspar is always formed in solutions containing carbonate of lime, when carbonic acid is set free. By exposing in a warm place a well-stoppered vessel containing a concentrated solution of carbonate of lime in excess of carbonic acid, crystals of calcspar were deposited.

Experiments were also made by Rose, with especial regard to the influence of the degree of dilution, and so forth, upon the result. He took two ordinary small flasks—one containing a very dilute solution of carbonate of soda, and the other containing a dilute solution of chloride of calcium; he tied them together, and then immersed them in a cylindrical vessel of water. He left them under the water, and, in consequence of diffusion, a mixture took place with extreme slowness, the chloride of calcium mixing with the carbonate of soda. In this case, the result was the formation of arragonite; and if the solutions were a little stronger, he then got calcspar. The conclusion, therefore is, that, under special conditions of dilution, arragonite may be formed even at the ordinary temperature.

In native arragonite a little carbonate of strontia is found frequently, but not always. Its maximum amount, taking a goodly number of analyses recorded, is stated at 2½ per cent. It ranges from a trace to 2½ per cent. At one time it was supposed that the carbonate of strontia was a universal and essential constituent of all arragonite, and that this determined its crystalline form. That opinion, however, has been shown to be an error, because we not unfrequently find arragonite free from strontia. A little water is also generally present in arragonite. The extremes given by a number of analyses are 0·17 per cent. and 0·41 per cent. Water is given as a constituent in all of them. Arragonite is deposited from hot springs, as at Carlsbad, where there is a well-known spring. It occurs also in gypsum at Molina, in Arragon, and at Dax, in the Landes. It is also found in basaltic rock in the serpentine rock in the Valley of St. Nicholas, in Piedmont, in lavas in Vesuvius and Iceland, in beds of brown iron ore at Saalfeld, the Harz, and Styria.

We now come to the mineral calcite, calcspar, or Iceland spar. This calcite is pure carbonate of lime. So far as analyses tell us, some specimens of Iceland spar are absolutely chemically pure. Sometimes they contain about one-half per cent. of water, and they not unfrequently enclose foreign matters, such as copper pyrites and sand.

Next, as to the formation of calcite. Calcspar, or crystallized carbonate of lime, crystallizes in the rhombic system. We have seen that it can be produced by means of water; we will now consider its production through the agency of fire only. We have all heard of the famous experiments of Sir James Hall; they were commenced in 1798, and the results were communicated to the Royal Society of Edinburgh. He informs us that he took amorphous carbonate of lime, or chalk, and by exposing it to a high temperature under considerable pressure, he succeeded in converting it into saccharoidal limestone, like Carrara marble. The lecturer had had an opportunity of seeing one specimen prepared by Sir James Hall, and he must say that the result did not strike him as conclusive. But now for the evidence. He enclosed carbonate of lime in gun-barrels, and resorted to various expedients of plugging those gun-barrels, such as plugs of soft metal, and so forth. He then exposed a portion of the gun-barrel to a high temperature, taking care to arrange the tube horizontally in such a manner that the plug of soft metal should not be melted; and he obtained a hard substance like limestone after having exposed chalk to these conditions. He says, "My first application of this scheme was carried on with a common gun-barrel cut off at the touch-hole, and welded very strongly at the breech by means of a plug of iron. Into it I introduced the carbonate, previously rammed into a cartridge of paper or pasteboard, in order to protect it from the iron, by which, in some former trials the subject of experiment had been contaminated throughout during the action of heat. I then rammed the rest of the barrel full of pounded clay, previously baked in a strong heat; and I had the muzzle closed like the breech, by a plug of iron welded upon it in a common forge, the rest of the barrel being kept cold during this operation by means of wet cloths." This gives you an idea of one of his experiments. Then he comes to the use of fusible metal. He employed tubes of glass. It is desirable particularly to examine the evidence upon this subject, because it is one on which much stress has been laid. The lecturer did not wish to question unnecessarily the accuracy of Sir James Hall's conclusions, but he might remark that the carbonate of lime being heated to a high temperature in contact with glass, the result would be altogether vitiated, and the crystallization could not be said to depend merely upon the outward conditions to which the substance was exposed. We find that in other experiments he used small quantities of carbonate of lime in contact with silica and clay; but the presence of these two bodies would very much modify the result. In other experiments he used borax, and that again would altogether vitiate the result. Therefore, the conclusions drawn from these experiments are unworthy of being received—at all events, without further evidence. He tells us that in several cases the material which he obtained, although resembling crystalline limestone, fell to pieces on exposure to the air. That, however, is not the property of crystalline limestone. No doubt the investigations of Sir James Hall were conducted with perfect honesty and candour, and they must have involved a great deal of expense; but, as far as we know, recourse was never had to chemical analysis, and without that no result ought to be received. Indeed, Sir James Hall himself confesses his deficiency in chemical knowledge. He tells us that in various experiments he got a product in glass-like drops which were semi-transparent, and this clearly proves that the carbonate of lime operated upon could not have been pure. Having carefully gone over these experiments, the lecturer had no hesitation in stating that he considered them to be unsatisfactory. "By the lens," he says, "this same surface was seen to be glazed all over, though irregularly, showing here and there some air-holes. In fracture it was semi-transparent, more vitreous than crystalline." Last of all, he uses platinum, to obviate the effect of the iron. The effect of the iron would be to act as a strongly reducing agent upon the carbonic acid by the formation of carbonic oxide, and the tendency to decompose the carbonate, would, of course, be facilitated by reasons which are well known to chemists.

It appears after all that Sir James Hall obtained some results which would certainly lead us to believe that, by the application of a strong red-heat, carbonate of lime would acquire a crystalline structure; but it is exceedingly desirable that these experiments should be repeated with all possible care, that the question may be cleared up satisfactorily. No doubt they would involve considerable expense; but if proper care were taken, and proper apparatus employed, there is no doubt that we should obtain something like very decisive results. The Hall experiments extended over several years; but, looking at the results, he could not feel that confidence which seems to be generally reposed in them. Some years ago, Gustave Rose took up the subject, and came to the conclusion that Sir James Hall had been entirely mistaken; but more recently he has come to an opposite conclusion. But Rose's experiments are by no means so conclusive as they might be. In his recent experiments, which are published only this year, and will be found in the 118th volume of Poggendorf's Annalen, by employing a wrought-iron vessel, electro-plated with nickel, and capable of being closed,—so avoiding the contact of iron at a high temperature with the carbonate of lime operated upon, and, consequently, the reducing action of that metal on the carbonic acid of the carbonate of line,—he succeeded in changing arragonite into a substance having the characteristic appearance of Carrara marble. The experiment, he tells us, was conducted in a Siemen's gas-furnace—that is, a furnace capable of sustaining a long-continued and high temperature. A closed, unglazed porcelain vessel was employed, and exposed to a white heat during half an hour; and he informs us that under these conditions a piece of lithographic stone became greyish-white in fracture, and, under a lens, was found to be finely granular. The product was analysed, and contained—lime, 56·61; magnesia, 0·41; carbonic acid, 42·37; residue, 0·45. Pure carbonate of lime contains 56 per cent. of lime and 44 per cent. of carbonic acid: what was the undetermined residue? The presence of a small amount of silica might make a considerable alteration in the result. After carefully examining the way in which Rose's experiment was conducted, it appears to me inconclusive. It is obvious that there could have been no sensible degree of pressure. The porcelain vessel was not in the least injured, so that the temperature must have been much below that which we can now command—as, for instance, in the fusion of platinum. It is most desirable that we should have some further investigation on the subject. The British Association might take up the question with advantage; they have funds at their command, and it would be exceedingly desirable to settle this important point once for all.

What we call carbonate of lime in nature—take even the purest marble—is not pure. At one time the lecturer was anxious to investigate this point, and he went to a sculptor and obtained numerous varieties of marble, but in not one of them did he fail to detect alumina. Chalk is an impure body, and the presence of foreign matter might altogether modify the results of experiments made with it. There is, for example, a well-known variety of fire-brick, which consists almost entirely of silica. Upon taking hold of it, you will find that it is a hard, solid, enduring brick. You may ask, "How could you get this silica to unite so as to form a hard brick?" For a long time it was kept secret: it was done by the intermingling of a very small proportion of lime, which caused the formation of one solid brick; and it is very possible that foreign matters might be present, and modify the result of experiments made on the crystallization of carbonate of lime. We ought to appeal to chemical analysis to inform us what we are doing. It is vain to rely upon experiments where chemical analysis is not brought into use, or we may be led into serious error.

The next question we shall have to consider is, the derivation of lime in nature. What ready source of carbonate of lime is there in nature? According to Bischoff, in his valuable and compendious book on chemical geology, it exists in the so-called Plutonic rocks in combination with silica, forming silicate of lime; and this compound is decomposed by water containing carbonic acid, even when in mechanical suspension in the water.

Dublin Royal Society.—*January* 18.—Mr. E. J. Reynolds read a paper "On Spectrum Analysis." In the latter part of his discourse, the application of the method of spectrum-analysis to the examination of minerals was treated of. In examining refractory minerals in order to obtain the characteristic spectra of the metals contained in them, the author employs a peculiar form of gas-jet, which is essentially a Herapath's blowpipe-jet urged by a current of steam rendered acid by hydrochloric acid. The steam-jet should never be so powerful as to blow the test specimen off the platinum wires. By this means the decomposition of many minerals is effected without having recourse to the previous action of ordinary chemical agents upon them, as has been hitherto necessary in preparing them for examination in the spectrum apparatus. The discussion of the real aid to be derived from the application of the spectrum analytical method to mineral analysis was then entered upon, and Mr. Reynolds expressed his belief, on experimental grounds, that the various spectra materially interfered with each other, notwithstanding the statements of MM. Bunsen and Kirchhoff and others to the contrary; and he showed that the presence of a considerable proportion of sodium and barium compounds, in a mixture of salts of different acids and bases, serves to completely mask or intercept the spectra of lithium, potassium, strontium, and calcium when present in comparatively small quantities. After discussing this portion of the subject at some length, the author expressed his belief that the method of spectrum-analysis, as it now stands, beautiful and delicate though its indications are, must be looked upon rather as a useful aid to the ordinary analytical process than as a method of analysis perfect in itself under all conditions. Mr. Reynolds concluded by observing that he has hitherto been unable to find any traces of rubidium or cæsium in any Irish minerals; but thallium was found in three specimens of copper-pyrites from different portions of the Knockmahon mines, Bonmahon, co. Waterford, and in one specimen of the same mineral from Ballydehobb mine, co. Cork. The amount of the metal present in every case was extremely minute.

ROYAL INSTITUTION.—*February* 26.—The Friday evening lecture was "On the Quaternary Flint Implements of Abbeville, Amiens, Hoxne, etc., their Geological Position and History." By Joseph Prestwich, F.R.S. —Mr. Prestwich remarked upon the imputation of rashness, and even of credulity, which discoveries such as that of the flint implements often entailed upon geologists. He contended that geologists were, on the contrary, generally disposed to be incredulous. At one time they believed that fishes were no older than the Carboniferous strata; that reptiles first appeared during the Liassic period; and that mammalia could not be traced beyond the Tertiary strata; and it was a long time before they were satisfied that fishes go back to the Silurian, reptiles to the Carboniferous,* and mammalia to the Triassic period. And so with man. Ten years ago there was scarcely a geologist in this country who would not have deemed the occurrence of the works of man in any beds older than the recent alluvium impossible. The discoveries made by Tournal and Christol in the south of France, thirty years since, of the remains of man associated with those of extinct mammalia, were rejected by geologists unanimously; nor were the analogous discoveries of Schmerling in Belgium more favourably received; whilst Frere's remarkable notice, so far back as 1797, of the discovery, at Hoxne, in Suffolk, of flint weapons mixed up with the bones of large extinct animals, was allowed to lie dormant for sixty years.

Even so late as 1855, a communication by the Torquay Natural History Society, respecting the occurrence of worked flints with the fossil bones in Kent's Cave,—a fact already, years before, noticed by the Rev. Mr. M'Enery and by Mr. Godwin-Austen,—was deemed, by the Geological Society, too improbable for publication.

Mr. Prestwich doubted whether, prior to 1858 and 1859, there were twenty men of science in Europe who would have admitted the possibility of the contemporaneity of man and of the extinct mammalia. He instanced Dr. Grant as one of the small number who, on abstract principles, treated the question as an open one. He also noticed the tone of confident disbelief with which the asserted occurrence of flint implements in certain geological deposits in the Somme valley was spoken of when he made inquiries respecting this subject in Paris in 1856 and 1857, and which for a time turned him from the inquiry. Such instances might be multiplied. The speaker did not bring them forward as indicating any perverse opposition, but to show how reluctant geologists were to abandon the belief generally held on this subject without the clearest proofs, and close and careful search on their part. Such, he remarked, is the inevitable progress of all discovery. Facts deemed contradictory to received theory are often long rejected, some as clearly failing in proof, others as non-proven. Evidence is hesitatingly received, and has to force its way through a resisting stratum of incredulity; but, as in the searching resistance offered by close tissues in the separation of mercury from its dross, that portion which passes through issues the brighter and purer the more difficult the transit, and the stronger the pressure exercised.

Allusion was then made to the distinguished palæontologist, Dr. Falconer—one man of science at least in this country with whom the conviction that the remains of man might be traced back to periods greatly antecedent to our ordinary records, had grown, during a long course of years, from probabilities suggested by Eastern research, into certainty established by extensive investigation among the European fossil-bone

* Possibly to the Old Red Sandstone.

caves. Referring to his late exploration of Brixham Cave in 1858, the attention which the well-certified discovery of flint implements in undoubted association with the remains of extinct mammalia and of reindeer attracted amongst geologists was remarked upon. The speaker visited the cave in company with Mr. Pengelly, and was much struck with the force of the evidence, though, for various reasons, he considered that cave evidence alone was not sufficient. Urged by Dr. Falconer to go and examine the geological evidence respecting the flint implements in the valley of the Somme, he afterwards paid his long-intended visit to Abbeville (where he, on the very first day, was fortunate enough to find three worked flints at Menchecourt.) He was joined, on the next day, at Amiens, by his friend Mr. John Evans. The geological evidence, and the character of the flint implements, satisfied them both that here again was an undoubted case of contemporaneity of the works of man with the remains of the extinct mammalia. All the author has since seen on many subsequent visits to the Somme valley, sometimes alone, but more frequently in company with other geologists, has tended to confirm his first opinion. He then proceeded to notice some of the phenomena he had seen, and to give his conclusions respecting them. He had intended to have described the several localities in France and England at which flint implements had been found, but found that time would not allow his going beyond Amiens. This was the less important, as Mr. Lubbock had so recently given an able account in the same room of most of these places; and his auditors were probably most of them acquainted with the more general account given by Sir Charles Lyell in his recent work on the 'Antiquity of Man.'

Mr. Prestwich then went on to describe the remarkable discovery of M. Boucher de Perthes, and how much honour and credit were due to him for his untiring perseverance, in face of general discouragement, for a period of twenty years, and for twelve years after the publication of his elaborate work, 'Antiquités Celtiques et Antédiluviennes.' Incited by this work, Dr. Rigollot, an antiquary of Amiens, discovered flint implements in great numbers near that town; but his careful memoir on the subject, although it attracted the momentary attention of some French geologists, was allowed to drop comparatively unnoticed. Geologists admitted the antiquity of the beds, and antiquaries admitted the workmanship of the implements; but neither would own to a conjoint interest and belief in them.

Before entering upon the details of the sections, Mr. Prestwich proceeded to make a few remarks upon the conditions under which the flint-implement-bearing beds were found, and how their importance and the time they represent were to be judged of. He observed that sea-formed deposits afforded massive and tangible monuments of the length of time required for their accumulation. But on land time passes, and builds no such monuments of its duration. The sand and shingle beds of a rapid river would be little, if at all, thicker now than a thousand years ago, for, instead of accumulating in the channel of that river, they are incessantly removed, and carried eventually out to sea, where they contribute to the formation of the great sedimentary deposits constantly going on there. The time represented by river deposits (apart from the recent silty alluvia) is not therefore to be measured by their thickness; and we must not attach the less importance to the beds containing the flint implements, because, being formed by river action, they are necessarily small, fragmentary, and superficial. But while in the sea the accumulation of matter has formed a relative measure of time, on land the extent of denudation resulting from the removal of a portion of that matter supplies an obverse scale. In the former case the lapse of time is chronicled by constantly accruing deposits, whereas in the latter case the deposits cannot exceed a certain thickness. They are constant quantities, and their dimensions are no measure of their age. The only test of their age consists in their organic remains, and in the depth of the valleys below the terraces on which portions of them are lodged. In speaking of river action, the author does not refer to the slow and sluggish streams of this country, but to the more active streams of countries of greater rainfall, or to old conditions of former periods.

Mr. Prestwich then proceeded to refer to a large pictorial section of the celebrated pit at St. Acheul, near Amiens. The artist had not visited Amiens, but had skilfully contrived to give a sufficiently accurate representation of the town and valley, for the purpose of showing the general relation which the ground there bore to the surrounding district. The details of the pit were, however, all given from actual survey by the speaker. The surface of the ground at the pit is 100 feet above the level of the Somme, which flows in the valley at the foot of the hill. The valley itself is about one mile broad. The hills on either side, rising to a height of 200 to 300 feet, consist of chalk, with a few and distant cappings of Tertiary strata.

On platforms of various breadths, generally on the top of low hills adjoining the valley, patches of gravel occur at intervals more or less long from the lower to the upper end of the valley, whilst a more connected series of gravel beds skirts the base of the valley. The chief portion of the valley is, however, occupied by alluvial beds, beneath which the last-mentioned gravels, with their brick-earth, pass.

The higher level gravels rarely contain organic remains. The pit at St. Acheul affords a singularly good example of these beds, and is unusually rich in organic remains, and also in flint implements.

The section exhibits :—	Feet.
1. Brick-earth (Loess) without organic remains	10 to 15
2. A variable bed of whitish, marly sand, with numerous *freshwater* and *land shells* of recent species, and a few *mammalian remains*	3 to 7
3. Variable beds of subangular flint gravel—some white, others ochreous and ferruginous. Numerous *fossil bones* and *flint implements*, and a few *shells* as above, irregularly dispersed throughout	5 to 14

These beds repose upon a base of chalk. The site having been long occupied as a Gallo-Roman cemetery, the upper brick-earth is intersected with pits and graves,—in some there are stone, or rather hard chalk, coffins, whilst in others the nails and ironwork alone remain, the wood having entirely decayed away. These portions of disturbed ground are easily recognized by their darker colour, their contents, but more especially by the break they produce in the stratification of the beds. So long as the ground is undisturbed the lines of the brick-earth, the lamination of the sands, and the rough bedding of the gravel are continued in horizontal planes without break. Any interference from above breaks these lines and mixes the different beds, and renders the disturbance at once apparent. In the absence of any such indications it is to be assumed the fossils and the flint implements are in undisturbed ground.

The flint implements are found scattered irregularly through the gravel, but they are more numerous in the lower part. It has been estimated that there is one implement to one cubic yard of gravel. They occur singly, and, as far as we know, lying flat. The spot where one was found *in situ* by Mr. Flower was pointed out in the section, and also the spot where the speaker and Mr. Evans extracted one. These worked flints partake of all the mineral characters of the gravel—the result of contemporaneous deposition. Some retain their original dark colour, others are stained yellow and brown; some have their outer surface converted to a bright white; many are encrusted with thin patches of carbonate of lime; and many again exhibit dendritic markings,—all being conditions in perfect harmony with the mass of broken subangular flints composing the body of the gravel, of which they are, in fact, component parts, showing one and the other like characters of age. Several hundred specimens of flint implements from this pit have passed under the speaker's inspection; thirty selected specimens were exhibited, showing the principal forms which prevailed, and in which the workmanship and design were most apparent. Few can feel any doubt who inspect a series of this nature. It is not so much evidence of art and skill that we look for, but primarily of design. The speaker did not dwell on this point, which is now generally accepted. It has been well treated by Mr. Evans and others.

The fossils consist of perfect and uninjured, though very friable, land and fresh-water shells in the following proportion, and of bones, mostly broken, and teeth of the following animals. The list is necessarily only a sketch.

Fauna of the Quaternary Gravels of the Somme Valley.

	ANIMALS.	SHELLS.
Extinct species.	Elephas primigenius.	14 species of land shells.
	Elephas antiquus.	
	Rhinoceros tichorhinus.	9 species of marine shells (Abbeville only).
	Hippopotamus.	
	Ursus spelæus.	
	Hyæna spelæa.	21 species of freshwater shells.
	Felis.	
Some extinct, some living.	Cervus (2 or more species).	All these are of species living in France, and all but one in England, except the Cyrena fluminalis, now living in the Nile and Central Asia.
	Bos (2 or more species).	
	Equus (2 species).	

Proceeding to interrogate the section with a view to determine the causes which led to the formation of these beds, the nature of the climate which then prevailed and their age, the following conclusions were deduced:—

1. The mineral ingredients of the gravel are chiefly broken flints derived from the chalk of the district in general, but with these there occur fragments and blocks of Tertiary sandstone and Tertiary fossils, which could only have come from places ten to twenty miles higher up the valley. Therefore the agency, whatever it was, that brought the débris here must have proceeded in a direction down the present valley, the Tertiary débris being found along that line as far as the sea. Further, the cause could not have been a general one extending beyond the present hydrographical basin, for none of the older rock débris from the valley of the

Oise, which is only separated by a watershed six miles broad from that of the Somme, passes from it into the latter valley.

2. The presence of freshwater shells in some of the intercalated beds, many such as live in clear and rapid streams, indicates a probable fluviatile origin for these deposits.

3. The mammalian remains and land shells give evidence of dry land. The occasional occurrence of bones in the position they hold during life shows that the carcases and limbs of animals were dropped into the old shingle before they were freed from their integuments, or within a short time after death, whilst the perfect state of preservation of the land shells is an indication of their not having been transported far.

All these characters tend to prove that these beds are to be referred to old river action. This, however, must have taken place when the river occupied a level about 100 feet higher than it does now. It is true that similar gravels, containing similar mammalian remains and also flint implements, occur at lower levels (forty feet) in the valley, whence it is inferred that similar causes were in operation when these also were deposited. But it is plain that the two could not have been deposited at the same time. For the deposition of the high-level gravels on the supposition that the valley had been previously excavated, would have required a river at some times filling a channel more than a mile wide and 100 feet deep—a state of things not to be accounted for under any circumstances. The alternative therefore of a river flowing at the higher level and gradually excavating its channel is adopted.

The character of the climate may be inferred from the fauna. The land and freshwater shells are of species now living in France, but they also range as far north as Russia, Finland, and Siberia. They are therefore such as, though occurring in temperate climates, are capable of existing in high northern latitudes. The animal remains furnish more positive testimony. The woolly mammoth and rhinoceros were fitted by their coating to endure the rigours of a cold climate, such as Russia and Siberia, where their remains abound, and where they seem to have fed on vegetation common to such latitudes. A species of tiger now lives in Central Asia, and is often tracked and hunted down in the winter on the snow and frozen lakes of that region. The reindeer, of which we have the remains in the valley of the Somme, and the musk ox, which occurs in the same deposits in the valley of the Thames, indicate still more clearly the northern tendencies of this group. There is a difficulty about the hippopotamus, but the elephant and rhinoceros originally presented the same difficulty; and there seems no reason why in this case also the extinct species should not be found to have been fitted to live in a severe climate.

These conclusions are corroborated by the physical phenomena. Mr. Prestwich pointed on the large section to numerous blocks of sandstone but little worn, and varying in weight from half to five tons, which could hardly have been carried and deposited, as now found, by water alone. He also showed various contortions in the upper beds of gravel (whilst the lower ones were hardly disturbed), and in the laminated sands overlying them. These he attributed to ice-action. The blocks, to transport from places higher up the valley on ice-floes at the breaking up of the ice in the spring, and the contortions to the grounding of ice-floes on the soft sand and loose gravel, impinging into them and piling up the gravel, as now occurs on the banks of some of the Canadian rivers. He pointed especially to the pendent masses of brick-earth isolated in the upper part of the sands, and which he attributed to angular masses of ice brought down in flood time, grounding on the brick-earth and pushing a portion of it into the underlying beds of sand, where, as the ice gradually melted, it would be left, caught, and squeezed in by the sand pressing itself into place again.

The two classes of evidence are, therefore, conformable. It is in harmony also with the existence of the large beds of brick-earth or loess overlying the gravel, and which is, doubtless, the deposit of the old river during floods, usual in a severe climate at the time of the melting of the winter snows. The winter climate may probably have been as rigorous as that of Northern Russia or Northern Canada. Such a climate would not be any bar to the presence of man, whose works are found in these old shingle beds. It is true that none of his remains have yet been found in these deposits, but they are found in caves of the same age. The abundance of animal remains is the almost inevitable consequence of a country subject to great river-floods, by which large numbers of animals are always destroyed and swept down; man, on the contrary, guards against such risks. Along the Northern American rivers of the present day, although the remains of the buffalo and other animals occur in profusion, the remains of man are scarcely ever met with. There is every reason to expect that this further and desirable proof may be forthcoming at no long distance of time.

Lastly, the speaker stated that the present river Somme only carries down fine silt and mud, whereas the old river transported large masses of coarse shingle; therefore, it is to be inferred that the old river was one of much greater power than the present one. During floods especially its power must have been very great; with greater transporting power the river would possess greater excavating power; at the same time the disintegration of rocks, especially such soft rocks as the chalk of this district, produced by severe cold, combined with the effects of ground ice lifting up from the bed of the river large quantities of the shingle, would hasten the deepening of the valley. As it deepened, terraces of shingle have been left at places on the slopes. It may be difficult to imagine a river with so limited a collecting ground filling a valley a mile wide, but this the speaker supposes to have been the case only during floods, and that the ordinary channel of the river was very much smaller. He instanced a case in India where Dr. Hooker mentions a river which was only eighty yards wide when he crossed it, but which, after the rains, covered a channel three miles wide, and ran ten to twelve feet deep. The melting of the snow in the spring produces the same result in arctic regions as heavy and continued rains in southern regions.

Mr. Prestwich next exhibited a diagram to show what he conceived to be the different phases of the phenomena, from the period when the beds of St. Acheul were formed, until the valley assumed its present form and dimensions. The plan, which was formed of a series of superimposed sections, showed—

1. *The old river during the deposition of the shingle and sand banks of St. Acheul.*—In this the bed of the river was occupied with large shingle banks, which were left dry during the time the river was low. Mr. Prestwich supposes these to have been resorted to by early man, in consequence of the number of large flints they contained, for making flint implements on the spot. This may be one of the reasons why they are so numerous at St. Acheul, which was shown to be one of those old shingle banks preserved from that time. Ice-floes dropped large blocks of sandstone into the shingle. A space shut off in part by a shingle bank would account for

the more tranquil accumulation of the middle sand-beds of St. Acheul, and for the more numerous shells living there undisturbed. During flood, the river rose probably to a height of twenty to thirty feet above its ordinary level, as shown by the brick-earth (without gravel) deposited higher up the hill on the road to Cagny. The next stage showed—

2. *The gravel beds of St. Acheul after they were left dry, except during floods.*—Here the valley had been excavated to several feet below the level of the St. Acheul beds, but during floods the river still extended over them and deposited the brick-earth. Ice-floes grounded and indented the upper beds of sand and gravel, causing contortion of the strata.

3. *The river at the time of the formation of the low-level gravel beds of St. Roch and Amiens.*—The valley had now deepened to the extent of fifty to sixty feet below the level of St. Acheul, and the low-level gravels of St. Roch were deposited under similar conditions, only that ice-action is not so strongly marked. It is in these beds that the remains of the *hippopotamus* first appear. The flint implements found in them are of a somewhat different type to those of the higher level gravels. The flake form is more prevalent.

4. *The low-level gravel of St. Roch, left dry except during floods.*—Here we have a repetition of the same state of things as found at St. Acheul; the shingle being covered up during floods by brick-earth or loess.

5. *The valley at the present period.*—The progress of excavation shows the valley deepened to its full extent. The river has lost its old power, its flood waters now rising only two to three feet, and its channel being restricted within a very narrow compass. The old and rough channel left at the end of the Quaternary period is covered to the depth of ten to twenty feet by fine alluvial soil and peat. All the great pachyderms have become extinct, but the reindeer, bison, and great fossil ox survived during part of the more modern time. Almost all the small and fragile land and freshwater shells have continued in uninterruped descent to the present day. This fact seems almost conclusive against any general cataclysm having passed over the surface. This concordance between the physical features and the contemporary life, and the capability the hypothesis here offered gives of explaining each and every one of the phenomena, affords strong presumptive proof of its truth.

Before concluding, Mr. Prestwich observed that he might be expected to say a few words respecting the age of the flint implements. Two questions were involved in this,—one the length of time elapsed since the close of the period of the extinct mammalia; the other, how far back into that period the flint implements can be traced. In the description of the sections, it had been previously pointed out, that the Quaternary period could probably be brought down immediately to the time when our valleys began their modern accumulation of silt and peat. The period of time, therefore, first to be measured is that which has been required for the formation of these latter deposits. On this point there is considerable difference of opinion amongst geologists. The occasion did not afford time to enter into the details of the question, and the speaker therefore contented himself with an expression of opinion offered with reserve. He considered that more time and better data were required to make a sure estimate; nevertheless, he was satisfied that the evidence, as it exists, does not warrant the extreme length of time so frequently supposed. The recent alluvia covering the latest Quaternary deposits of our valleys are rarely more than forty feet thick, in most cases not more than twenty feet. The rate of accumulation, though it may often be slow, is very variable. A Roman road in the valley of the Lea was found covered by two feet only of alluvium. Another such road in Cambridgeshire was covered with five feet of alluvium. The entire depth of the alluvium was not, however, ascertained in either case. M. Rozet gives another instance of a Roman road, which he considers to have been kept in repair until about the eighth century, traversing the valley of the Dheune. Its paved and even surface is now covered by twelve inches and a half of alluvial soil. A little lower down the valley this alluvium, which is very uniform, has been ascertained to be about thirteen feet thick. This he estimates would have required for its accumulation about 10,000 years. The alluvial soil reposes there immediately on the so-called diluvium. The rapidity with which the alluvial soil will accumulate under favourable conditions is often very much greater. In places, thick beds of alluvium and of peat have been formed since the Roman occupation. Looking at these facts, and at the general fact, that as a rule, in the valleys of the Somme and of the Thames, for example, the Roman, British, or Gaulish remains are found at a depth from the surface bearing a considerable proportion to the entire thickness of the alluvium, the probability is, that the commencement of the alluvial deposits is not to be carried back indefinitely.

One reason for believing the accumulation of the silty alluvium of our valleys to have been more rapid at one time than now is, that these valleys, left rude and rugged at the end of the Quaternary period, would be subject to more frequent floods until their inequalities were filled up and levelled. Mr. Prestwich concluded by observing that for these and various other reasons he was confirmed in the opinion he expressed in 1859, that "the evidence, as it stood, seemed to me as much to necessitate the bringing forward of the extinct animals towards our own time as the carrying back of man in geological time." In making that observation, he had chiefly in view the distance of time at which the last of the great extinct mammalia disappeared. If there should have been, between the modern valley alluvia and the latest Quaternary beds, some intervening period of time of which we are ignorant, that distance may be materially prolonged. If, on the contrary, they followed in immediate succession,—and he thought we have evidence that such was the case, for there seems reason to believe that some of the large pachyderms still existed at the commencement of the alluvial period, whilst we know that many of the ruminants lived on uninterruptedly from one period to the other,—he did not, for his part, see any geological reasons why the great extinct mammalia should not have lived down to comparatively recent times, possibly not further back than 8000 to 10,000 years.

"But this only brings us to the threshold of that dim and mysterious antiquity in which first appear those rudely-wrought flints—those evident works of design—those palpable shadowings of man. Here our chronology fails us altogether. If we look at our broad and long valleys, and then at the comparatively small streams now winding through them, and suppose these streams to have been the same in past times as they now are, we could hardly avoid the conclusion that the time required to produce such excavations with such means must be almost incalculable. But if the view here proposed be correct, it would follow that with rivers so large in proportion to those now occupying the same valleys, with floods of a force now unknown in the same districts, with a cold so severe as to shatter the rocks and to hasten the removal of their débris, we should have, I contend, agencies in operation so far exceeding in power any now acting in these countries, that it is impossible to apply the same rules to the two periods. The changes described must have progressed with a rapidity of which we, at the present day, can in these latitudes hardly form an adequate conception.

"But, although I would shorten the Quaternary period by the extent of the differences here alluded to, it still remains of great length and importance, stretching back into a far remote antiquity, and it is far into this period that we have traced these works of man. Although at present we are without a scale or measure to determine that antiquity, we need not abandon the hope that, by continued and careful observation, we may eventually succeed in forming some comparative estimate of it. The first men who, after traversing the plains of Lombardy, approached the Alps, could scarcely have failed to realize their vast dimensions, although without the means to determine their exact height; so we, from the relative magnitude of the phenomena and the variation of life, can sufficiently well realize the remoteness of the time in question, although we do not possess the data whereby to measure its duration, and determine its exact distance from our own time."

Royal Geological Society of Ireland.—*April* 13.—The Rev. the Vice-Provost of Trinity College, President.

The President announced that as the change in the constitution of the society, which was announced on the notice-paper for the evening, might necessitate some slight change in the bye-laws, he would request that any gentleman who had candidates to propose for the honour of Fellowship of the society would mention their names, so that they might be balloted for at the next meeting.

The following names were then proposed:—A. Gahan, Esq., C.E.; H. Russell, Esq.; R. T. Brabazon, Esq.; R. Glascott Symes, Esq.; and Sandford Palmer, Esq. R. H. Ellis, Esq. was proposed as an Associate.

Mr. Scott read the following report from Council:—The idea has been frequently mooted within the last few years, that it would be advisable to have the name of the society altered, so as to make it the Geological Society of Ireland, as the title Geological Society of Dublin appears to confine its labours to the immediate vicinity of this city; whereas by the original resolution, passed in 1832, its objects were so defined as to embrace the whole of Ireland. In addition to this change, several influential members were of opinion that the addition of the word "Royal" to its title would be of great importance, as indicating that her Majesty was disposed to recognize its labours. The council accordingly, at their meeting on the 17th of February, appointed a sub-committee, consisting of the Rev. Professor Haughton, with the treasurers and secretaries, with full powers to act as they thought best. The sub-committee drew up a memorial, which was suitably engrossed, and they requested the following members to sign it:—The Earls of Enniskillen, Bandon, and Dunraven; Lords Talbot de Malahide and Dunally; Sir R. Griffith, Bart., with the President. They further requested Lord Talbot de Malahide, as a former President of the society, to have the kindness to forward the memorial to the Home Office, and they enclosed with it a complete copy of the Journal of the society for her Majesty's acceptance. The council have the honour to submit the reply which her Majesty has been graciously pleased to return to their memorial; and they cannot but, in the first instance, congratulate the society on this proof that their labours during the past year have been appreciated, as they would consider they deserve to be; and secondly, express a hope that the fact of the recognition of this body as the "Royal Geological Society of Ireland" may incite the Fellows to still further exertions in the cause of their favourite science. In conclusion, the council desire to tender their most sincere thanks to Lord Talbot de Malahide, to whose kindness they consider themselves mainly indebted for the successful issue to which their application has been brought. They would also express their warmest acknowledgments to Mr. Robert Mallet, F.R.S., who, though no longer resident in Dublin, is still unremitting in his interest in the society, of which he has been so long a distinguished member, and whose unceasing exertions in regard of this special accession of dignity to it have at last been crowned with success:—

"Whitehall, March 28, 1864.

"My Lord,—I have had the honour to lay before the Queen the petition, transmitted in your letter of the 17th instant, of certain members of the Geological Society of Dublin, on behalf of that Society, and I am to inform your Lordship that her Majesty has been graciously pleased to comply with the prayer of the petition, and to signify her desire that the Geological Society of Dublin be henceforth called 'The Royal Geological Society of Ireland,' and that the members thereof be styled 'Fellows of the Royal Geological Society of Ireland.' I am commanded by her Majesty to convey to the Society her thanks for the copy of the Journal of their proceedings, forwarded by your Lordship, which has been placed in the Royal Library at Windsor.—I have the honour to be, my Lord, your Lordship's obedient servant, (Signed) "G. Grey.

"The Lord Talbot de Malahide."

Mr. Ormsby read a paper on "A Polished and Striated Surface in the Limestone of Ross Hill, County Galway." On the Midland Railway, between Galway and Oranmore, there is a low range of hills, over which the line passes nearly at the surface of the ground. Some time since it was thought expedient to lower the road here to improve the gradients. When the surface clay was removed, a large portion of the top of the rock, for upwards of three hundred yards in length, was found to be brightly polished, grooved, and striated. Several borings were then made in the fields on each side, and different results obtained; but they all showed that the surface of the limestone beneath was smoothed and polished over a very considerable area. In various places in the rock were deep grooves, as if a plough had been driven over it, the cuts having in some cases sharp, jagged edges and a bold outline,—in others, soft, gentle slopes, like ripple marks on a sandstone. These deeper grooves and the principal striæ were in a direction nearly parallel to the railway, or magnetic east and west, while a series of minor striations run north-east and south-west. The former seem to be due to the violent rubbing of ice, most probably in the form of a glacier, and the latter may be ascribed to the subsequent action of the drift.

Mr. Jukes said that the society was indebted to Mr. Ormsby for the care with which he had investigated the subject, to which his own attention had been drawn by Mr. Ormsby in the course of last winter. He had lately visited the locality himself, and he could only say that the phenomenon was much more striking on a large scale than could be supposed from the inspection of a hand specimen. Surfaces fifty or sixty yards in length were laid bare, quite smooth, and dipping at a uniform angle of about half a degree. These smooth surfaces had been covered with clay, and their appearance was very different from that of surfaces which had been long exposed, showing how the erosive action of the air destroyed the markings of the direct action of ice. He (Mr. Jukes) did not know whether the polish was supposed to be produced by ice itself or by the clay beneath moving ice, an agency which would seem to him to have been necessary. At all events, from the gently undulating character of the country, it would seem that the ice did not belong to local glaciers, but more probably to a large sheet covering the whole surface of the district. In connection with this subject he would mention that his friend Dr. Melville, of Galway, had expressed the opinion that in the neighbourhood of that town they had the true "boulder clay" of Scotland, while in the east of Ireland the superficial deposit had been subjected to a considerable sifting action, which had changed its character. The general opinion at the present day is that this boulder clay is not aqueous drift, but consists of the débris of rocks ground down on dry land. Not far from Galway he had observed a sandy clay full of boulders, so compacted together as to form a sort of conglomerate, in parts almost stratified, which had been probably formed by the pushing action of the ice slipping from the land to the sea.

The Secretary read a paper by W. Harte, Esq., C.E., "On a New Echinoderm from the Yellow Sandstone of Donegal." The fossil which I have the honour to bring under the notice of the Royal Geological Society of Ireland, and of which I request their acceptance for their museum, was obtained by me lately in making a road on the western shore of Lough Eske, about six miles from Donegal. The specimen is a cast in the yellow sandstone, the markings being in an unusually good state of preservation. The shape is orbicular—depressed,—the base is wanting, and the cast seems to have yielded by pressure and is spread out, somewhat of a bell-mouthed shape, though this has been effected with very little distortion or disarrangement of the plates. The interambulacral spaces are composed at the lower extremity of the fossil of five rows of plates, and it is probable that they exceeded that number at the base. The two rows next the ambulacra are pentagonal except the upper plates, which are nearly triangular. The other three rows are hexagonal, very irregular, and nearly all become obsolete before reaching the ambulacra. These hexagonal plates are almost smooth, or at least only marked by very minute tubercles, of which, I think, traces can be detected. The genital and side pentagonal plates are very different. The genital plates have each a large perforate tubercle, as in Archæocidaris, surrounded by a depressed ring, and this is again surrounded by a ring of about sixteen pores. Of the rows next the ambulacra the first plate (counting downwards from the apex), which is nearly triangular, has a small tubercle. The rest of the plates in this row are all pentagonal, and both they and the tubercles increase in size downwards. The second, fourth, and seventh plates have each one large tubercle, surrounded by a depressed ring, and this again by a circle of very small tubercles. The third, fifth, and sixth plates are quite plain. The foregoing description applies to all the interambulacral spaces, so that thus we have a series of concentric circles in the pentagonal rows at increasing distances from the apex down. The ambulacra are large; the perforations are situated in two depressions, and consist of three rows of two each (six rows in all) in each ambulacral depression. Three small plates cover each space, and there are two perforations in each plate. Four of the ambulacral plates equal in depth one of the side plates. The dividing ridge shows the ambulacral plates well, having one small tubercle in each. A detached portion of either this same, or of another of these specimens, appears on the same stone close to it, showing the plates of the ambulacra very distinctly. There are no traces of any spines that I can see in this fossil, unlike the fossils of Archæocidaris to which I shall presently allude. This specimen appears to have been stripped of its spines before being buried in the sand. I have, however, found in the same bed, and near the same place, a few detached plates and the casts of what appear to be spines. I also find traces of large plates in some of the friable shales near it. The fossils associated with this specimen are not numerous. I have sent up a good specimen of *Psammodus porosus* from the same bed. In the limestone which underlies the sandstone there are a great abundance of fossils, of which by far the most characteristic are remains of Archæocidaris, which occur in the greatest profusion. They are found in groups of plates and spines; nearly all of these groups present more or less the same assemblage of hexagonal and pentagonal plates, the former tubercled, with numerous spines both smooth and muricated, giving the idea that each of these groups represents the remains of one or more of these animals as they fell to pieces. In no case do I find among these any pentagonal plates provided with tubercles like those of the cast in the sandstone; and accordingly differing, as it does, from both Palæchinus and Archæocidaris, I think that there can be no doubt that it is a new addition to the Echinoderms of the carboniferous period.—The paper was illustrated by a careful drawing of the specimen on an enlarged scale, for which the society was indebted to the kindness of Mr. Bailey, who, on being called on by the President, observed, that in his opinion the fossil belonged to the genus Archæocidaris, but was certainly a new species. He was led to this conclusion from the fact that the whole family of the Cidaridæ presented an appearance like that shown on the specimen, viz. that the plates exhibited one large tubercle. In the more recent specimens all the plates were tubercled, while in this Palæozoic fossil the tubercles only appeared on a few of them. He would only observe, in conclusion, that the society owed a great deal to Mr. Harte, by whose care and diligence this fossil had been discovered and laid before them, like many others which they had received from the same locality within the last few years.

Mr. Emerson Reynolds then read a short communication upon "Thalliferous Pyrites, from Ballydehob, county Cork." He said that he had examined several Irish ores for this element since he had laid his last notice on this subject before them in 1863, but that the present specimen was the only one in which he had succeeded in discovering thallium, and here only in small quantity.

Geological Society.—*April* 13.—1. "On the Geology and Mines of the Nevada Territory." By Mr. W. Phipps Blake.—In describing the physical features of the country, the author observed that it is an elevated semi-desert region, composed of a succession of longitudinal mountain-ranges with intermediate valleys and plains, the most abundant rocks being metamorphic and igneous; but Tertiary strata and Carboniferous Limestone also occur.

The author then described the hot springs, which are extended along a line of fissure in a granitic rock, and parallel to the mountains, and which deposit silica in an amorphous and a granular state, sulphur being also seen in the cracks and cavities of the siliceous deposit. He considered these phenomena to illustrate the formation of a quartz-vein in a fissure.

Mr. Blake then gave an account of certain mineral veins in porphyry, which yield sulphurets of silver (including crystals of Stephanite, but very little ruby silver) and a little gold; also galena, copper pyrites, iron pyrites, and a little native silver, the veinstone being a friable quartz. The prevailing direction of the veins was stated to be nearly north and south; and the author remarked that they were richer in gold near the surface than at greater depths.

2. "On the Red Rock in the Section at Hunstanton." By Mr. Harry Seeley, F.G.S., of the Woodwardian Museum, Cambridge.—The physical structure of the rock was first considered, and it was shown to be divisible into three beds, the uppermost of which is of a much lighter colour than the rest, the middle being concretionary in structure, and the lower sandy. These three beds, with the overlying white sponge-bed, were considered to belong to one formation, and were treated of in this paper as the Hunstanton Rock; but the thin band of red chalk some distance above was considered, though of similar colour, to be quite distinct, as also was the Carstone below.

Mr. Seeley then showed that near Cambridge the Shanklin sands and the Gault have both become very thin, so that there is a great probability of the latter being unconformable to the beds above as well as to those below. He considered the lower part of the Carstone to be of the age of the Shanklin sands; and as the chalk is not unconformable to the Hunstanton rock, he concluded that the latter could not be the Gault, but must be the Upper Greensand,—a conclusion which he afterwards showed was supported by the evidence of the fossils, and the occurrence of phosphate of lime.

The seam of soapy clay which separates the Hunstanton rock from the chalk was supposed to have resulted from the disintegration of a portion of the former, the red colour of which the author endeavoured to show was due to Glauconite.

The upper part of the red rock of Speeton was thought to be possibly newer than that of Hunstanton, and perhaps to represent the time which elapsed between the formation of the latter and that of the band of red chalk.

In conclusion, Mr. Seeley remarked that as the phosphate of lime is confined to Bed No. 2, and as many individuals of Gault species occur in Bed No. 3, while others of a chalk character are met with in Bed No. 1, it is very probable that the Hunstanton rock is a more typical example of the Upper Greensand than is seen at Cambridge, and may represent also those periods which separate that formation from other divisions of the Cretaceous system.

FOREIGN INTELLIGENCE.

On some Mammalian Remains from the Neighbourhood of Vienna. By Dr. Zittel.—A beautifully preserved upper jaw of *Anchitherium Aurelianense* has been found in the brown coal of Leiding, near Pitten (south of Vienna). Since the late Mr. Partsch some years since stated the occurrence of this remarkable species in the Neogene limestone of Brack, on the Leitha (south-east of Vienna), it has not been found within the basin of Vienna. The jaw under notice, an inferior tooth from the marine sands of Grossbach, and an upper tooth from the brackish "Tegel" of Nussdorf (west of Vienna), prove this animal to have occurred in each of the three periods during which mammalia made their appearance within the Vienna basin.

On some Upper Cretaceous Cœloptychia. By Director Hörnes.—Mr. Grotrian, of Brunswick, has presented the Imperial Museum of

Vienna with a series of five species of this genus of Spongiaria (*Cœloptychium agaricoides*, Goldf., *C. deciminum*, Roem., *C. incisivum*, Roem., *C. subciferum*, Roem., and *C. lobatum*, Goldf.), all of them beautifully preserved and prepared with uncommon care. These fossils occur near Vordorf, two hours' distance north of Brunswick, in a mass of Upper Cretaceous Limestone, which at places appears through the uniform diluvial deposits characteristic of the extensive plain of North Germany. *Belemnitella mucronata*, D'Orb., *B. quadrata*, D'Orb., *Micraster coranguinum*, Lam., and *Ananchytes ovata*, Lam., are the characteristic organic remains in this limestone. Cœloptychia are not exclusively confined to the upper or Belemnitella-horizons of the Cretaceous deposits. The rarest among them are *C. incisum*, *C. sulciferum*, and *C. lobatum*.

On the Bayreuth Sandstones. By Professor Gümbel.—These sandstones, remarkable for the abundance of fossil vegetable remains preserved in them, are equivalent to the bone-bed strata of Würtemberg. They are, in every locality hitherto known, invariably overlaid by the normal lowest Liassic strata, with *Ammonites angulatus*, *Thalossites*, etc. These passage-beds, which are neither decidedly Keuperian, nor properly Liassic, would be best distinguished from both by the special denomination "Rhætic division."

On some Neogene Fossils from Transylvania. By Chev. Fr. Ritter von Hauer.—Mr. Rang has presented to the Museum of the Imperial Geological Institute a series of organic remains from the argillaceous sphærosiderite of Biharcz falva (Transylvania), metamorphized into brown hydroxide of iron. Among them are many specimens of a Congeria (*C. triangularis*, Partsch), and a cast of a Paludina (*P. Sadleri*, Partsch), proving once more the lignitiferous and ferriferous basaltic breccias of Transylvania to be geologically equivalent to the Neogene Cerithian strata. (Proceed. Impl. Geol. Instit. Vienna, May 19 and Dec. 1, 1863.)*

* The above notes are communicated by Count Marschall, of Vienna.

REVIEW.

Popular Geology of Darlington. By R. T. Manson, Vice-President Naturalists' Society. 'DarlingtonTimes' Office, 1864.

This little work is in pamphlet form, containing thirty-two pages; and consists of six articles, originally written for the 'Darlington and Stockton Times,' in 1860, which, having been altered and enlarged, are now reprinted. The first chapter is devoted to the "Bulmer stone," in Northgate—a famous granite boulder; the second, to the quarries near Sheldon station, worked in the "Stinkstein" and Permian beds; the third, to the coal strata of Thukley and Sheldon; the fourth, to the great Whin Dyke; and the fifth, to the Trias of Darlington itself. An appendix, giving the localities for fossils, is added; and acknowledgments to Mr. Howse, of Sunderland, Mr. Janson, of Darlington, Mr. Edward Wood, of Richmond—the last of whom possesses a most valuable collection of fishes from the locality described—brings this useful, instructive, and popularly written work to a close. Such local books can but induce to spread a taste for research and the collecting of fossils. We hope the sale will remunerate the author and publishers.

THE GEOLOGIST.

JUNE 1864.

THE PRIMARY TRANSLATION OF THE EARTH.

BY THE EDITOR.

IN reference to the correspondence on my speculations in theoretical geology and astronomy which have been printed in this Journal, I wish to take this opportunity of saying, that if in the cases of the Rev. O. Fisher, p. 54 in this volume, and of Dr. Leslie, p. 295 in Vol. VI., I have inserted such comments on any of the physical hypotheses to which from time to time I have given expression without replying to those comments, that I do not therefore acknowledge my opponents to be right, nor, on the other hand, do I intend to pass them over slightingly as wrong, or as unworthy of attention. I simply thought it best not to get into controversy *while* my own ideas were being enunciated. I cannot, however, concur in the Rev. O. Fisher's views as to the possibility of the earth's velocity, if initial primarily, being maintained, nor of a larger orbit for our planet being a result of any retardation of her motion. I am well aware of Kepler's law referred to, and I have my own opinion both of its value and its application. Mathematics may derive a result from a given basis, but mathematics never yet gave birth to a basis of facts. That two added to two make four may be mathematically demonstrated, but no amount of mathematical reasoning would prove four to be derived from two and two. It is evident it might have been derived from $3+1$, or $1+1+1+1$. Just so if the orbital velocity of our earth had been imparted to it by explosion, by condensation, by any *projectile* force whatever, its tendency of motion must have first been in a *straight* line; and as the projectile-force would have been greater at its origin than after ages upon ages of retardation, the earth would therefore primarily have had a greater antagonistic force to the attraction of the sun, and the higher the centrifugal force, the greater the expanse of her orbit. The more we twirl a mop the more it spreads, and no amount of Kepler's laws, or anybody else's, would get over the physical fact, or convince people against their eyesight or their senses. Astronomers *must* make their calculations and predictions upon *definite* forms, such as circles, ellipses, parabolas, parallelograms, and so forth. They must *assume* these if they do not exist—and they do not. But there is no astronomical calculation rigidly correct, and the slightest deviation is fatal to the doctrine of the permanence and fixity and unalterability of the celestial mechanism and planetary motions. There is no such fixity. All is change everywhere through boundless space—slow, elaborating, perfecting; altering, changing, destroying—change—like life and death—everywhere without exception.

To return to the point asserted, that "if the distance of a planet from the sun be increased, the velocity in the orbit will be diminished." If the velocity of the earth be due to a primary projection, that projection could not have been *circular;* there is no such force as circular projection known. We cannot shoot round a corner even with a bent gun. Therefore if the earth's orbital motion be due to any original projectile-force, the primary direction of the earth's course must have been *direct;* and this normal course can only have been turned into a circular revolution round the sun by the sun's *superior* attractive power. If, then, the *superiority* of the sun's attractive power over the earth's direct motion be *increased* by the *diminution* of the original projectile-force through ages of slight resistance by the ether of space, then the *ever-increasing difference of that superiority* will ever and ever be *reducing the orbit* into closer and closer proximity to the central attracting sun. Thus therefore it is evident that if the world acquired its orbital motion, or rather its translation through space, by any explosion, or condensation of nebulous matter, or any other source of *projectile-force*, its orbit must be a constantly increasing or a constantly diminishing *spiral*. It is quite evident also that if the earth did possess any given and definite initial velocity, that velocity *must remain the same*, unless affected and diminished by the resistance of the medium through which it travels. If one hundred miles a second were the initial velocity of the earth, removing the earth's orbit to the confines of celestial space could not increase that velocity by a mile, an inch in a second, if the resisting medium remained the same. The force that started gave the velocity, and the earth must get an additional kick, so to speak, while running, to have its orbital velocity increased. Now force acts *equally in all directions;* and if a grain of gunpowder were exploded in mid air, it would blow out in all directions alike. So if any explosion or explosive condensation of nebulous matter took place in space, it would act in all directions alike; it would be a sphere of explosion, or a globular result from the condensation of matter within a given spherical area of space. The motion of such an explosion would be like sunlight radiating in every direction; the motion produced by such a condensation would be exactly the reverse, or like the crushing in-rush of air into an exhausted globe of glass—an incoming to a central spot from all around. Neither explosion nor condensation in space could give rise to projectile-force; and if therefore this world *was* formed by the condensation or the explosion of nebulous matter, neither that condensation nor that explosion could cause the translation of our resulting earth from one part of space to another. There could be no projection of a world in space *without a wall or fulcrum of denser space for the projecting force to act against.* A cannon ball could not be projected from an open tube; the gases of the gunpowder in the cannon act against the breach and find a fulcrum there. Where are gases exploding in open celestial space to find a wall of resistance that shall give the explosion a projectile-force? We cannot conceive. Neither explosion nor condensation therefore could give rise either to direct or to revolutionary orbital motion round the sun; it is impossible. It even seems more natural to seek for the causes of planetary orbital motion in motions of the ether of space. The incandescence of the sun must put any ethereal matter surrounding it for millions upon millions of miles around in a state of intense vibration. If the sun be in combustion—and spectral analysis shows it to be—oxygen or some other combustion-supporting gas must, one would fancy, be constantly indrawn towards it; while the heated and unburnt particles of the ether of space, or of the products of combustion, would as constantly be driven out into space. Might there be thus produced in the circumambient area around our luminary constant in-settings and out-settings of gaseous particles the friction of which against a free spherical planet might effect a rotatory motion of it? If so, would the length of day and night depend on the strength of these settings? If the supply of fire-supporting gases swept in grand spiral currents to the central burning sun, would the planets float in these currents in spiral orbital revolutions? *Then*, indeed, Kepler's law would hold good that the further from the sun the *slower* the orbital motion. But with an original projectile velocity that result could never happen.

FOSSIL BIRDS.

By the Editor.

(*Continued from page* 53.)

It is certainly very much out of stratigraphical order to jump from the fossil bird-remains of the Stonesfield Slate to those of the Tertiary beds of the Paris basin; nor is such a step in any accordance with historical order. We are simply compelled to take it, through the necessity of saying a few words in explanation of certain plates which have been issued with the previous numbers of this volume. The gap, however, in the historical series is not so very wide; and it is by no means useless in this place to run over afresh the review which the great Cuvier made of the labours of his predecessors. A section of vol. iii. of his famous work, 'Recherches sur les Ossements Fossiles,' published in 1812,* was devoted to the remains of birds. "Naturalists," he begins, "are agreed that, of all animals, birds are those whose bones or other relics are the most rarely found in the fossil state. Some even absolutely deny that any have ever been met with; and indeed, by one of those singular accidents reserved for the beds of gypsum of our neighbourhood, there are scarcely any other well-preserved fossil bones of birds than those they have furnished." He then, to show the correctness of this statement, and the then recent knowledge even of the fossil birds of the *plâtrières* of Paris, glances over the statements of Walch, Hermann, Camper, Blumenbach, Faujas, Lamanon, Gesner, Luid, Wallerius and Linnæus, Davila and others, the accounts of most of which have been already given in our previous articles.

"Walch, he says, "had met with several; Hermann added others. Their indications serve us as guides, without however exempting us from going to the original; for the first deceives himself many times in spite of this precaution." Conrad Gesner, he observes, early declared that the stones named after birds, such as the *hiéracites* and the *perdicites*, had no other affinity with them than resemblances of colour; but "rude figures of birds," he adds, "accidentally traced in coloured stones, certainly do not properly belong to the Ornitholites,

* We quote from the 5th edition, published in 1835.—S. J. M.

any more than stones or pebbles having some sort of similitude to parts of birds, such as the 'cock' of Agricola and the 'hen' of Mylius, imprinted on the schist of Illmenau. Other authors have also," he continues, "regarded very gratuitously as Ornitholites some fossil bones, merely on account of their lightness and slenderness, but which a very slight examination would suffice to prove those of fish, small quadrupeds, and sometimes even to be parts of shells and crustaceans."

"Thus the *sulcata littoralis rostrata* of Luid (Lith. Brit. t. 17) appears to me but the extremity of the dentated spine of the fin of some fish. The 'beaks' of the environs of Weimar and Jena, of which Wallerius and Linnæus speak, are only, according to Walch, who has been in that country, but superficial resemblances. Rom. Delille, in the Catalogue of the Cabinet of Davila, cites a beak from the environs of Reutlingen (Cat. iii. p. 225), which has been adopted by Linnæus, and a bone from Cronstadt, which appeared to him to be a fowl's; but his 'beak' seems to be only a bivalve shell showing itself obliquely at the surface of the stone. If it were a true beak, it differed prodigiously from all that we now know of existing birds; and as to the bone, there is neither description nor figure in his work. Scheuchzer speaks (Mus. Dil. p. 106) of a bird's head in a black schist of Eisleben; but he adds immediately, that 'one might also take it for a gillyflower,'—quite sufficient to judge it by. Others (Lesser, *Lithothéol.*, Wallerius) quote the description of the environs of Massel by Hermann, as if he there spoke of bones of birds; but that author really announces only *little bones*, without saying that they may be those of birds. The error of compilers with respect to the petrified cuckoo (*coucou*) of Zannichelli * is still greater and truly funny. He alludes to the fish *coucou*, a species of Trigla (*Trigla cuculus*, Linn.; in Italian, *pesce capone*), and not to the bird. Other reports have neither descriptions nor figures sufficient to justify them. Such is that of Volkman, in his 'Silesia Subterranea' (p. 144), and those brought forward by the systematic mineralogists. . . . It is clear that incrustations do not belong to our subject; and if the accounts of them were all true, they would prove nothing as to the existence of Ornitholites."

There remained then, after these eliminations by Cuvier, in the works of previous authors only the relics in certain schists, such as those of Œningen, Pappenheim, and Monte Bolca, which could have any claims to a serious examination, and which could really have been taken for Ornitholites by thorough naturalists.

"Now," says Cuvier, "nearly all that has been cited is more or less equivocal, or, at least, is not substantiated by sufficient figures and descriptions. These schists abound in all sorts of fish and other products of the sea; the bones in them are compressed. Who would dare to flatter himself as being able to distinguish in this state a fish-bone from a bird-bone? The feathers even, are they easy to be distinguished from the Sertulariæ? How, then, can an inconsiderable portion be judged of, such as a member? The best authority for an investigation of this kind undeniably should be that of M. Blumenbach; but he limits himself to saying, that there

* Dargentville, Or. p. 333, and Walch, Com. sur Know. ii. p. 11.

have been found at Œningen *bones of littoral birds* (*'os d'oiseaux de rivage'*), in Mém. d'Hist. Nat. (Trad. Fr.) ii. 408. As to those of Pappenheim, he refers to the Memoirs of the Academy of Manheim (Act. as Theod. pal. v. pars, phys. 63); but it is surely questionable, from the locality given, whether it may not be a very singular reptile, of which we shall speak hereafter (our Pterodactyle), and not, as M. Blumenbach calls it, a *palmipede bird*. Zannichelli had what he called a 'beak' from Œningen; but was it more real than that of Davila?"* Scheuchzer cites a feather from the same place (Mus. Dil. p. 106; Pisc. Quer. p. 14; Phys. Sac. i. t. 53, f. 22); but he did not convince Fortis, who believed it was only a Sertularia (Jour. de Phys. flor. an viii. p. 334); nor Hermann, who, he says, is always ridiculing this pretended feather (*op. cit.* p. 340). We should have them under our eyes to judge. Fortis was not more convinced of the examples of feathers from Monte Bocla, which he saw at Verona (*op. cit.* p. 334), two of which have been published by M. Faujas (Annales du Muséum d'Hist. Nat. vol. vi. p. 21, pl. 1). I confess, however, that if there are any portions able to carry conviction, they are those which I have examined with the greatest care many times, and in which I can discover no character whatever to distinguish them from feathers (*des plumes*). But, in supposing they may be such indeed, they would prove nothing against my previous assertion; there have been none as yet well preserved, except in our gypsum."

Cuvier then refers to Lamanon's description, in 1782, of the bird found at Montmartre by M. Darcet, and of which he admits there can be no doubt. He notices, however, that Lamanon has put in the feathers of the wings and tail, and has unfortunately given his imagination a little play; he insinuates, also, that the drawing is not very like the original. He moreover tells us that Fortis, who had conceived strong prejudices against the existence of Ornitholites, examined afresh what had been described by Lamanon, and gave a figure according to his own ideas; thereby affording a very remarkable illustration of the degrees of difference the same object may assume under eyes that regard it in a different aspect. "We can distinguish nothing," says Cuvier, "in the figure given by Fortis; the head is upside down, all the inequalities of the stone are exaggerated, the osseous imprints weakened; in short, the author declares he can see in this fragment only a frog or a toad."

The fact is, however, as Cuvier states, and there can be no doubt at all that this specimen is a veritable ornitholite.

"But," he adds, "one could hardly have dared to sustain it if there had not since been found in our plaster-works pieces more characteristic and suited to confirm it. Peter Camper mentions one, but without describing it, in an article on the fossil bones of Maestricht, published in the Philosophical Transactions for 1786. It is a foot found at Montmartre, of which M. Camper, jun., has sent me a drawing, which I have had engraved in the 'Bulletin de la Société Philomathique,' for Fructidor, An VIII. I had myself a second piece, also a foot. This was from Clignancourt, below Montmartre. I described it in a note read before the Institute the 13 Thermidor, An VIII., and published in the 'Journal de Physique' of

* Was not the aptychus of the Ammonite sometimes noticed under the term "beak" by some of the old writers?—S. J. M.

FOSSIL BIRDS FROM THE PARIS BEDS.

the same month, p. 128, etc., with an engraving (pl. i.), which was reproduced in the 'Bulletin de la Société Philomathique,' for Fructidor, An VIII., and afterwards in different foreign journals. On this occasion I learnt there existed two others in the hands of a private person at Abbeville, M. Elluin, engraver, who had also received them from Montmartre; and M. de Lamétherie gave a copy, in the same number of his Journal (pl. ii.), of a drawing sent him by Mr. Traullé. It was the body of one bird and the leg of another. It was easy to see that the leg did not belong to the same individual, and also that the incrusting stone came from another bed. Such is the judgment of MM. Baillet and Traullé (Journ. de Phys. Therm. an viii. p. 132), which M. de Burtin confirms in a note to a description of this fossil, published by M. Goret, of Abbeville (Trs. Soc. d'Emulation). Having had the specimen for some time under our eyes, we have assured ourselves of the correctness of this fact. There have been, then, since 1800, four different well-marked fragments; that of M. Darcet makes the fifth. Since then I have continued my researches, and have found such a great number that there can be no longer any doubt that our plaster-beds contain many remains (*beaucoup de débris*) of birds."

These specimens, which he had collected, Cuvier then goes on to describe, beginning with the feet, "as being the most striking parts even for least accustomed eyes." "Indeed," he continues, "the foot of any bird whatever is composed in an absolutely particular manner, and does not resemble that of any other animal."

The specimens of fossil birds from the environs of Paris figured and described by Cuvier are:—

"1. A very complete leg and foot of a common species from the Gypsum (vii.)*; 2, end of tibia and foot complete of same species; 3, foot of bird from M. de Lamétherie's cabinet (vi.); 4, fragments of the foot of a bird, showing the first phalanges of the thumb and outside and middle digits, probably the same species as No. 6 (iv.); 5, inferior mandible; 6, copy of Elluin's specimen; 7, tarsal bone of a bird of the same species as No. 11; 8, leg of bird, showing the entire tibia, the thumb, and three other digits very complete (vii.); 9, foot of bird of same species as No. 11 (v.); 10, bird's foot described and figured by Cuvier in 1800 (viii.) allied to (vii.) species, and of the order *Grallæ* (storks and herons); 11, leg and foot of a bird much smaller than No. 4 (v.); 12, Darcet's specimen, a different species from any other (x.); 13, the two sides of a badly-preserved body, M. Elluin's specimen, drawn by Cuvier; 14, phalange of a bird's foot of a larger species than any of the others (i.); 15, portion of the wing of a bird, with the end of the humerus, the cubitus, the two carpal bones, the imprint of the apophysis of the metacarpal bone carrying the thumb and the imprint of a part of another metacarpal; 16, portion of wing in the cabinets of M. de Lamétherie, allied to the sea-larks (*Pelidna*, Cuv.) (viii.); 17, rib of fossil bird; 18, radius; 19, radius (x.); 20, humerus of littoral bird, anterior and posterior faces (iv.?); 21, humerus (ix.); 22, humerus (ix.); 23, end of omoplate of a bird resembling, in diminutive, that of a cormorant; 24, femur of a bird near to the genus *Pelican*; 25, femur of a bird of the order *Grallæ* and the genus *Ibis*; 26, portion of the trunk and both wings, and femur of a fossil bird (ix.); 27, well-preserved

* The Roman numerals indicate Cuvier's species. Cuvier did not assign any names to the species he indicated.

ornitholite from Montmartre, of the family *Gallinaceæ* (v.), showing the under-beak, its right ramus nearly entire, portions of both sides of the base of the cranium, vertebræ of neck, right clavicle, and parts of the left, small portion of the omoplate, the sternum much crushed and disfigured, and an equally disfigured impression of the pelvis, the tibia, and many other intelligible parts; 28, the four phalanges of a medius of a bird of prey, like their analogues in the buzzard (ii.); 29, lower mandible; 30, a 'frog-bone' (junction of the two clavicles); 31, coracoid bone; 32, another coracoid; 33, metacarpal and phalanges; 34, inferior mandible of a bird (v.); 35, humerus (v.?); 36, another humerus; 37, small humerus of (x.) and 38, leg and foot of the same species, No. 33; 39, small bird's foot (ix.?); 40, metacarpal of bird of prey of large size, and with long wings of the dimensions of the bald-buzzard, probably the same species as No. 24 (xi.); 41, another metacarpal of a bird of prey, much smaller, and having much shorter wings, probably of the same species as No. 48; 42, skeleton from Montmartre (ix.), the wing extended, humerus nearly entire, sternum crushed, feet and right leg well shown, as are also other bones; 43, well-preserved and characteristic skeleton from Montmartre, of the same species (ix.) as the foregoing, showing the head and beak, portion of the 'frog-bone,' back-bone, ribs, wing-bones, legs and feet, and other parts, very little disturbed from their natural condition; 43, mutilated humerus of a singular species, and like that of the screech-owl; 44, radius; 45, well-preserved foot; 46, badly-preserved foot of same species as No. 11 (v.)."

It will be seen then that Cuvier founds on these bird-remains no fewer than ten species. His first on the foot, described by him in 1800, in which the thumb or hind-toe is wanting (No. 10); but we see in the specimen the little bone, which carries it in many birds. These characters are much more complete in No. 8; the femur in that specimen is wanting, but the tibia is much more entire, and the thumb and the three other digits are very complete, and furnished with all the articulations they ought to have; the foot of this specimen having the tibia and tarsus a little longer than the first, is made another species by Cuvier. Of M. de Lamétherie's specimen, Cuvier makes a third species; of M. Elluin's a fourth; of the foot No. 15, which he thinks somewhat smaller than the last, a fifth; of No. 38 a sixth; of the four phalanges forming the medius of a bird of prey, No. 28, allied to the buzzard, a seventh; of the phalange of the great bird, No. 14, an eighth; and of the small foot, No. 39, a ninth species, all founded on the débris of the walking limbs alone. He founds three other species on the beaks in Nos. 5, 29, 39, respectively. We can scarcely analyse further Cuvier's work without giving additional figures, which our fast-closing limits will not allow. We can therefore only add that our Plates give examples of—No. 43 (Pl. III., fig. 1); No. 42 (Pl. VI., fig. 3); No. 41 (Pl. VI., fig. 2); No. 39 (Pl. VI., fig. 1); No. 25 (Pl. VI., fig. 4); No. 20, anterior and posterior views (Pl. VI., fig. 5); No. 15 (Pl. VI., fig. 7); No. 13 *a* (Pl. VI., fig. 6); No. 13 *b* (Pl. IV., fig. 2); and regret being cut off in the middle of our survey of the bibliography and present state of ornithological palæontology, the only manageable portion for anything at all like concisely showing the very imperfect state of our present knowledge of the past history of organic life on our globe.

ON THE GLACIAL DRIFT OF FURNESS, LANCASHIRE.

By Miss E. Hodgson.

The following sketch of the glacial deposits of Furness is not pretended to be complete; it is, in fact, nothing but a sketch: neither can it presume to be free from errors. The marine drift, especially, has not received all the attention it demands, but will, I hope, with the clays and peats of Furness, form a subject for a future memoir. The deposits in the section are referred *doubtfully* to their periods.

Striated Rock Surfaces.—The district of Furness; its south-eastern part, however, does not perhaps present so many of those remarkable records of the glacial period, the striated rock-surfaces, as are to be met with in more mountainous districts. The rocks, especially the Carboniferous Limestone and Permian formations, either lie in a great measure hidden under a thick covering of deposits, or, as in the hills of the Upper Silurian strata, are of such a soft decomposing nature, that they retain very little primitive facing.

Occasionally, however, striations may be found. A little way in shore, west from the estuary of the Crake, at the head of Morecambe Bay, a rock-surface recently exposed by the removal of the overlying material, and now quarried away, showed a series of parallel shallow groovings from an inch to an inch and a half apart; the intervening spaces plane and smoothed, and having very fine striæ. The striæ and grooving had a direction from E. to W., or perhaps a little N.E. to S.W. The rock presented an extraordinary and beautiful appearance, with no signs of fracture, but on attempting to break off a specimen, it was found to be literally crushed to pieces as if it had been an egg-shell: so that no specimen exhibiting more than one groove and smooth space could possibly be obtained.

South of this, and still not far from shore, but with a hill of more than 300 feet elevation lying between, striæ are found taking a S.W. by S. direction. The same occurs very distinctly on other spots near. Further west, on Ben Crag, a hill of nearly 500 feet elevation, the same N.E. by N. and S.W. by S. striation is observed, protected by the grassy sod.

It is found again with a very little variation on the Carboniferous Limestone, where it underlies the Boulder-clay on the shore between Bardsea and Aldingham. Some exposed beds of the limestone, levelled off and polished, have it very persistently, in fine parallel lines, now nearly worn out by the sea.

This direction of striæ corresponds with the general trend of the hills of Furness, as well as with the line of the centre of Morecambe Bay. But even where this is not the case, where the strike of the hills, so to speak, is N.W. and S.E., with a narrow vale or channel lying between, the striæ will be found having the same undeviating direction right across from N.E. by N. to S.W. by S. This is exemplified in the hills bordering the vale of Newland, near Ulverstone, where a brook now runs from 300 to 400 feet below the heights on each side. There is no question, however, but that the gill is deeper than when the ice crossed it, but the striation is repeated on the N.E. side down to 275 feet from the top, and at rather more than 125 feet above the brook; while it is a curious fact that this happens to be about the elevation above the brook, of the lowest obtained striæ on the S.W. side.

At the same time, although this is very likely to be the prevailing tendency of striæ in Furness, yet there are exceptions, and a slight deviation will sometimes occur between two points within a short distance of each other. Thus, on Gameswell Hill, deep groovings pass from N.N.E. to S.S.W., while rather more than half a mile off the striation is from E.N.E. to W.S.W. Yet neither of the two striations can have any connection with the present features of the locality. The gill that passes under Gameswell on the west cuts directly N. and S., and the rocks with the latter striation are on the south-eastern slope of a fell, down which small drainage depressions pass to the E. and S.E.

It should be conceded, I think, to the inexperienced student, that there may be great difficulty sometimes in selecting glacial striæ out of "weathered" lines of cleavage and stratification in the slate rocks. The difficulty is not when they present their edges sharp, close, and regular; but when *e.g.* somewhat resembling the spreading leaves of an opened book, they have been further worn into horizontal hollows, ruts, or grooves; and this, possibly, by the glacier passing over at right angles to them, rather than parallel with them, as would be at first suggested. The above is only one out of other instances of deception met with on decomposing slate rocks. It must occasionally happen that true striæ may run parallel with either the cleavage or bedding; but in these doubtful cases I have uniformly abandoned them, and it is not unlikely that good genuine striæ, which the experienced geologist would have noted down, may thus have escaped.

On the craggy heights of the moors, as well as in some places on the shore, the aspect of the rocks indicate that the principal denuding force has been carried over from the north. They generally present their smoothed sides to the north or north-east, their rugged ones to the opposite point; deep ruts passing up the smooth incline answering in point of depth to the opposition that incline had presented. In some instances the edges of the cleavage planes have been so shaved off, grooved across at right angles, and rounded, as strikingly to resemble the laminated structure of a shell-hill contour.

With regard to the form and outline of many of our hills, the beautiful description given at some length by Mr. Geikie, of the glaciation among the mountains of Scotland, might well serve for a description of these. Indeed, so truly do the glacial footsteps tell the same tale everywhere, varying only in degree of magnificence, that it would seem there can be only one set of terms happily and faithfully to record it in. Furness is not without "that union of prominent yet rounded crag and gently curving hollow which indicates the passage of the ice-sheet, with hardly less clearness than the ripple on the shore tells of the retreat of the sea,"* and lit up by the slanting rays of the evening sun, assuredly it yields nothing in point of interest and loveliness to the prouder types of Scotland. Besides being of frequent occurrence on our moors, this feature is especially conspicuous on the hills at Newland, and from thence, obscured a little by plantations to the head of the bay, where it again becomes traceable up the valley of the Crake. It first arrested my attention and had its true cause assigned to it in my note-book, after visiting in the autumn of last year the Roches Moutonnées in the vale of the Rotha at Ambleside, described by Mr. Hull,† and cited by Sir C. Lyell in his 'Antiquity of Man.'‡ "When a geologist," says Mr. Geikie, "has once familiarized himself with its varieties even in one locality, there are not many landscapes in the country where he will fail to detect its presence."

Roches Moutonnées.—True Roches Moutonnées lie on the eastern outskirts of Ulverstone. There is one close to the railway viaduct over the canal; it has been quarried, but still retains much of its remarkably rounded form. Another in the peat-mosses on the N.E. of the canal, is buried under the railway embankment; the domed top long refused to afford good foundation.

Stream Valleys.—In a deep narrow gill of the Silurian strata, close to Ulverstone, the striation seems to denote that the glacier in its progress has taken the curve of the gill, as it swerves from W. by N. and E. by S. to N.W. by N. and S.E. by S. It is difficult to fix the amount of glaciation in this gill; rocks of Devonian age have been swept out, but to what extent they may have been developed it is impossible to guess. I have always associated its glaciation in point of age (whether correctly or not I cannot say), with the forming of some remarkable indentations on the moor of Osmotherley, about a mile distant. These miniature glens, as they might be called, are deep, dry, parallel hollows, having a N.W. and S.E. direction, converging a little as they descend the moor-side, and fall into the drainage line leading to Ulverstone. Doubtless they differ little in character from many other depressions on the moors, but the singular, almost mural outline, they assume on the horizon is very arresting to the eye, and although they may mark the course of occasional rivulets, yet it is scarcely likely they are water-formed unaided by ice. As yet, however, no striæ have been detected in them. The crags in the vicinity are greatly crushed, a circumstance not alto-

* Geikie, 'On the Phenomena of the Glacial Drift of Scotland.'
† Hull, Edin. New Phil. Journal, vol. xi. p. 81, 1860.
‡ Geol. Evidence of the Antiq. of Man.

gether to be assigned, I believe, to atmospheric agency, either in this or any of the numerous instances of crushed strata on moors. Most of our stream-valleys, doubtless, owe their present features to the softening of the climate and the final melting down of ice; a transition not wholly insignificant in its effects even here, when we regard those escarpments of deposits, whether marine or glacier-formed, which tower loftily along many of their lines, sometimes on one side, sometimes on the other, and individually faced, perhaps, by a gentle verdant slope, that, with the gurgling brook below, seems to hide, as it were, under a calm disguise, all the tumult of the past. One of these escarpments on the line of the Pennington Beck is crested by "hummocks" of boulder clay, so artificial in form that tradition holds them as the site of an ancient castle, a half-encircling hollow, apparently water-formed, answering for the remains of the castle-ditch. I have an impression that geologists familiar with the phenomena of the period, would experience little difficulty in assigning this (together with much of the physical aspect of that truly interesting vicinity) entirely to glaciation and its subsequent modifying agencies. Almost every stone and pebble about the place is wonderfully grooved and striated.

The other features of our stream-valleys are the stripes or terraces which at various elevations and distances mark the former river-possessions, inasmuch as when tried by the spirit-level, they are found to be on an extremely gentle incline, thus affording additional evidence that all our brooks have been rivers, and our rivers mighty streams. Deposits of river-gravels occur at some heights above the present brooks, as in the vale of Newland before alluded to. There deposits of dark gravels and sands lie in underneath the hillside boulder clay, while the latter appears to have been scooped out by the flow and wash of the down-passing current, into a true overhanging river-bank, 50 feet above the bed of the present stream.

Boulder clay.—In slightly sketching out the position of the boulder clay in Furness, what knowledge I have of the nature and composition of that deposit is mainly derived from the teaching of the admirable memoir before referred to, 'On the Phenomena of the Glacial Drift of Scotland,' aided by the close examination of numberless specimens obtained from many localities. Its *stones and boulders rounded, angular, flattened, smoothed, striated, seldom of remote transportation, disposed without stratification in a more or less clayey material,* are the characters by which it may be distinguished here. But there are other peculiarities of the boulder clay in Furness for which the above work somewhat prepares the student. These are the bars, thin seams, or beds of gravels and sands, which very frequently are found running through it. These are neither fluviatile nor marine; they precisely resemble in lithological character the true boulder clay in which they occur: the stones, in some instances at least, have scarcely lost their striation, and clearly owe their stratified disposal to the percolation of water. In fact, such beds must have been simply melting zones in the heart of the glacier. Sometimes they rest upon the rock surface under the boulder clay, at others they alternate with it in more or less equal thickness throughout its depth, and occasionally they are found lying next the surface-soil. No doubt by being now, what they became then, passages for water, they are constantly and gradually extending themselves into the hard substance of the boulder clay.

By obtaining rough sections of numerous well-sinkings in the boulder clay, under the town of Ulverstone, a pretty accurate knowledge of these stratified beds is arrived at. They are known to the sinker as waterbars, and are, I think, identical in character with those seen in section on the moors, and in the Furness railway cutting. They are often found dry: hence several are passed before one containing water is reached.

They are described as having an average dip or incline of one quarter of an inch in five feet. The gravels lie between yellow sand-beds, which are smooth on their interior surfaces (*i.e.* the surfaces in contact with the gravels) and very compact. The pebbles are chiefly "*bright-blue*" (Silurian). Occasionally granite pebbles occur, and have this peculiarity, that the beds containing them are seldom more than two inches thick. The boulder clay is said to shade off gradually in colour from the yellow sands to that of its own, which is generally bluish, though occasionally other tints prevail. Under the west of the town the boulder clay is so hard as to break the pick point, is very dry, and free of gravel seams for a great depth.

This interesting deposit occurs in patches on our hills, is spread more thickly on our moors, descends next the rock-surface into the vales, forms fine sections on our south-eastern shores, and declines down under the marine stratified drift, at the southern end of the promontory.

At the Lindale moor iron mines, a good section of nearly half a mile is displayed by the sinking of the ground since the removal of the underlying ore. The following measurements were taken for me in two places along this section:—

	ft.	in.
Soil.		
Boulder clay	5	0
Sand and gravel	2	6
Boulder clay	3	0
Soil.		
Boulder clay	6	0
Sand and gravel	2	0
Boulder clay	9	0

There is a pretty general uniformity in the upper deposits throughout the length, but in some parts the lower boulder clay attains a much greater thickness. The gravels dip gently to the south-east. In long dry weather the laminated sands become inconspicuous; but here and there a red tinge pervades the series and denotes the occasional presence of water charged with iron. The boulder clay here is of a dark ochreous colour, in fact, just the colour of the highly decomposed Silurian pebble, and seems perfectly to answer to its final débris. The stones in good preservation, are much striated, and the boulders beautifully smoothed and grooved. In this *arena*, encircled partly by rock (Silurian) with boulder clay in section, and partly by the refuse heaps, the student of glacial phenomena may find ample occupation. Ice-scratched boulders of limestone and intercalated iron-ore, are there thrown to light; while lying out exposed, are huge blocks of the former, marvellously cut and hacked in every possible direction. The effect of turbid water upon stone is shown here. The limestone blocks within its influence have undergone great decomposition, and are moulded down into grotesque figures and shapes, similar to what are seen on the surface of limestone commons, and used for ornamental rock-work. Their surfaces are rough as sandstone, coated with a fine, almost impalpable, red powder. They are imbedded in a dark brown substance, probably "Black Mack," described by Mr. Cameron, vol. xix. page 27 of the 'Quarterly Journal of the Geological Society.'

When the stratified beds in the boulder clay rest upon the rock, although the rounded or planed outline may be preserved, it is found to possess a much rougher surface than when covered by the unstratified boulder clay. This is seen on the rounded rock by the viaduct before noticed; one side of which is covered by the following beds:—

Soil.	ft.	in.
Boulder clay, with striated stones	3	0
Large stones and sand	2	0
Pebbles mixed with sand	1	6
Grey sand		6
Larger pebbles		3
Sharp grey gravel		3

The Silurian rock under these is beautifully hollowed out and rounded, but it is extremely rough to the hand, is very soft, and shows symptoms of decay.

In a limestone quarry, north-west of Ulverstone, in a well-sinking nearer the town, and also, I believe, in the railway-cutting, roughened and curiously-shaped limestones, similar to those near the iron ore, have been met with, lying under stratified gravels, capped with boulder clay. In the quarry instance, I imagine the upper bed has been much broken up, antecedently to the moulding and roughening of the fragments. They are imbedded in a soft plastic clay; clearly, I think, a deposit from water.

But there is another, and perhaps more difficult problem connected with the boulder clay, which is, when loose gravels and sand, in no respect differing from that deposit in lithological character, lie next the surface-soil.

This is the case on Gill Brow: a moraine bank, a mile to the south-east of Lindale moor, at about 300 feet elevation above the sea.

A mining section there gives:—

	yds.	ft.
Soil.		
Loose gravel and sand		5
Hard boulder clay to rock	9	0

The stones in the loose strata of gravel and sand are some of them well striated. The thickness of deposits on the top of the hill, is much greater than below.

This bank, and another contiguous to it, appear to be extensions of moraine matter from the higher grounds of Lindale Moor, High Banks, Carr Kettle and Walthwaite Moors, and lie immediately between these and the Plain of Swarthmoor, which is one large spread of boulder clay. Gill Brow would moreover, in all probability, form a side bank on the great ice-flood line of the Pennington Beck, although now situated nearly a mile from the stream. The loose gravel stratum therefore might be part of the delta of that flood. No other suggestion presents itself to my mind. The striations would forbid the gravels being regarded as marine.

In the section formed by the railway-cutting, now grown over, the stratified beds were observed "running in very thin seams" through the boulder clay. They seem to be a constant and familiar accompaniment to that deposit, in the Carboniferous and Silurian grounds of Furness. With the boulder clay on the Permian, I am not yet so well acquainted. Its most southern inland extension, I believe, is at Harbarrow, three and a half miles from the south point of Furness; not far from here, it probably declines down under the red marl of Leece. In piercing through that deposit, near the Leece Tarn, for water, it was supposed to be the boulder clay that was reached at the depth of 112 feet.

Stratified Marine Drift.—It does not appear that the stratified marine drift of Furness can be said to attain in any thickness, to elevations much above 100 feet. Travelled and unstriated boulders, some of great size, water-rolled stones foreign to the district, and stray fragments of shells, are certainly met with; the latter even up to 500 feet, but no undisturbed truly marine deposits exist at such elevations to my knowledge. Several large stones, quite foreign to the district, occur upon and in the boulder clay of Lindale and the neighbouring moors; whether they may be regarded as the remnants of out-swept marine drift, and as marking the base of renewed glaciation, it is difficult to say. Many of them, notwithstanding their hardness, have all the appearance of glacial friction, being much smoothed down and flattened.

Probably they are marine deposits, which we find lying above a mile in shore, at the Ulverstone Railway Station, and extending up the Pennington Vale, to a little above 100 feet; but I believe these are met by, and to some degree commingled, and interstratified with old fluviatile deposits.

In sinking a well some years ago on the south of the town, between the one hundred and the seventy-five contours, a bar of small bivalve shells* was discovered, 8 feet below the surface, in a deposit of fine sand. I have not yet found any on this horizon in other localities, but it may be worth while prosecuting the search further. Passing southward marine drift appears to line the shore at about the same elevation from Ulverstone through the grounds of Conishead Priory to Bardsea. Here they are cut off, and we do not recognize them again till we get below Leece, where they are found sweeping over the promontory from east to west in elongated ridges, one or two of which, by the gradual inroads of the sea, have come to form headlands on the southern shore.

Coast-line Deposits.—One of these headlands, Rabbit Hill, at Barrow in Furness, saved from the sea by railway constructions, is now rapidly undergoing demolition to form levelled sites for streets, and its long entombed granite boulders thrown out to the light of day. On the south coast of Furness, at Back-House-Close Point,† 25 feet raised beaches, containing layers of existing British shells, and abutting against the headland, have in the recollection of persons now living been cut away by the sea. It is the same at Cunninger Point, while in what may have been, so to speak, the recesses of the coast, some still remain; only in their turn to yield eventually to the constant wasting of high tides. Traces of their broken lines occur all the way from Rampside to Aldingham, where they begin to recline on the boulder clay. The former tide-floor presented by this deposit appears to have supplied a clayeyness to the shell and pebble matrix, which renders their extraction, at this particular spot, extremely difficult, the mass being nearly as hard as the boulder clay itself.

For the naming of the shells, I am wholly indebted to the kindness of my friend Miss Gifford, of Minshead, Somerset:—

SHELL LIST.

Murex erinaceus.	*Turbo (Litorina) rudis.*
Buccinum undatum.	*Ostrea edulis.*
Buccinum reticulatum.	*Ostrea (Pecten) varians.*
Purpura lapillus.	*Mytillus edulis.*
Turritella terebra.	*Gardium edule.*
Turbo (Litorina) litorea.	*Mactra solida.*
Turbo (Litorina) neritoides.	*Tellina solidula.*

Turbo (Litorina) rudis was most abundantly found in the hard shell-beds at Aldingham. Of this species, Mr. Woodward remarks, that it frequents a higher region than *T. litorea*, where it is scarcely

* From the description, I judge they might be Tellina.

† Some of the stones in this cliff are striated, leading to the supposition that it might prove to be an outstanding ridge of the boulder clay resting on Permian strata. As I did not discover the fact of their striation on the spot, it must be left undetermined for the present. Stratified beds of sands appeared in the upper part of the cliff, but its face was much obscured by water springs washing the sands down from above.

reached by the tide. *Murex erinaceus* was only found in these beds, and rare.

Proceeding northwards up the coast, the finest sections in Furness of the boulder clay are exhibited in the cliffs or sea-scarps of Moat Hill, Edge Bank, Beanwell Bank, and Tea Wood, with heights ranging from 50 to 90 feet. Large Carboniferous (or mountain) limestone, boulders, and angular blocks seem ready to slide down; while hard detached and fallen masses become separated in time by the dash and spray of the tides, and strew the shore. Some of the fallen blocks measure 20 feet in circumference, and retain deep groovings on their surfaces.

North of Ulverstone, the boulder clay reappears at Hammerside Point, and constitutes a hill of 60 feet altitude, with an unknown depth. After this, it caps the Carboniferous and Silurian rocks of Plumpton and Threadlow; and then retires back and is not seen again on our line of coast.

CORRESPONDENCE.

On the Outer Tegument of a Section of the Genus Trigonia.

Sir,—Permit me to direct the attention of palæontologists to a remarkable feature in a section of the genus Trigonia, which indicates a wider separation of that section from its congeneric allies, and also an unsuspected imperfection in the state of preservation of some of our most common Jurassic testacea. It has long been known that under the name of *Trigonia costata*, some very different forms of that genus have been figured and described by various authors from Jurassic rocks ranging from the Upper Lias to the Kimmeridge Clay, including fossils from Oolitic limestones, sandy rocks, argillaceous limestones, and from soft unctuous clays. Considering that the materials at the disposal of authors have been derived from such a variety of rocks, and of localities, both European and Oriental, and that such numbers of the great group of the Costatæ have been examined and compared by so many authorities, it might have been expected that their natural-history characters had been fully ascertained, and that the little we have still to learn respecting them would have reference only to the separation or union of species, and to a more accurate definition of their stratigraphical range. I was therefore recently much surprised upon applying my pocket lens to the surface of a fine example of *T. Calypso*, D'Orb., to find that it exhibited a beautifully ornamented surface, consisting of lines of minute granules arranged vertically, and in every respect agreeing with the outer tegument of Gresslya, Anatina, Goniomya, and Myacites, amongst the Myadæ or Anatinidæ. Of this latter family the fossil forms with granulated surfaces may be separated into two divisions, the one having large and widely separated lines of granules, the other with the granules also linear, but very minute, and the rows closely arranged; *Trigonia Calypso*, from the Scarborough Cornbrash, has this latter kind of ornamentation easily overlooked, and preserved only under the most favourable circumstances. Other Trigoniæ with surfaces precisely similar are *T. elongata*, Sow., from the Cornbrash of the same locality, and from the Oxford Clay of Dorsetshire; *T. costata*, var. *lineolata*, Ag., from the grey limestone of Scarborough; another lunulate and lengthened form from the Upper Trigonia grit, Inferior Oolite near Stroud; *T. monilifera*, Ag., from the Coral Rag of Weymouth; and *T. marginata*, Lyc., from the Kimmeridge Clay of Wiltshire. This granulated surface occurring, as is now ascertained, in so many species of the costated Trigoniæ, whose general forms and other characters are very dissimilar, renders it evident that the whole group of the Costatæ is characterized by its presence, although we may only expect to discover it occasionally in specimens derived from fine argillaceous deposits, and cleared simply by washing, or by using only a light brush. The other sections of Trigonia having tubercles, varices, or serrated ribs upon the sides, appear to have been destitute of this granulated tegument, as are also the recent Trigoniæ. I would also venture to remark that the value of the granulated tegument as a ground of distinction in the groups of testacea, does not appear to be sufficiently appreciated by some palæontologists; that it is of higher value to us than as a separation between species, may be inferred from the fact that in the great family of the fossil Anatinidæ it characterizes all the species of the genera in which it occurs, and that the present appears to be the first known instance in which a well-defined genus can be separated into two sections, the one having the surface granulated, the other smooth: in Trigonia, however, it is found to pervade only a single but large and well-defined group, which in its general characters is as clearly separated from the other fossil groups as from the recent members of the genus.

JOHN LYCETT, M.D.

Scarborough, May 4th, 1864.

On the Nebular Theory.

Salford, May 17, 1864.

SIR,—In No. 75 of your 'Geologist,' I find an article on Planetary Orbits, etc., written with a considerable degree of ingenuity, in which you ask, and I suppose with no objection to a reply, for instances "of the evolution of light and heat by *slow* condensation of gaseous matter." Chemistry supplies us with abundance of proof in this respect. One of the most familiar is shale loaded with iron pyrites, which, when exposed to the influence of the atmosphere, often takes fire from the slow absorption of gaseous matter.

So, on the other hand, excessive heat has greater power than chemical affinity, and will, if supplied in sufficient intensity, release the condensed oxygen again from its compound. Metals, too, have a very great power to condense gaseous matter within their pores, and this power is generally proportionate to their spongy and divided character; but if heated, their affinity for gaseous bodies is likewise proportionately increased. But as I have just stated, heat has a greater power than chemical affinity, and therefore no condensation of gaseous matter could take place until it was sufficiently cooled to be within the range of chemical power.

Now the nebular theory assumes that condensation is the result of slow cooling, and could not have taken place in any other manner; consequently, no universal conflagration and condensation could simultaneously have taken place, as your reasoning supposes. Again, if we closely examine the crust of the earth, especially amongst the igneous rocks, with which we only profess now to deal, we shall find that they are combinations of the most infusible character, and, *à priori*, bodies which would be the first condensed, especially when their strong affinities are taken into consideration. And those bodies which are easily dissipated by heat are almost wholly excluded, such as water, carbonic acid, etc.

There is another argument I wish to point out, which I think is erroneous. You suppose that the heat of the earth is sufficiently accounted for on the grounds of its retardation through the ether of space. A little reflection will show that a body once heated to its maximum temperature, from whatever cause, whether in passing through air or the ether of space, if the medium be uniform in resistance and the motion constant, the heated body must necessarily diminish in temperature until it is reduced to the same degree of heat as the medium through which it passes. The reasons are obvious. The original cause of heat in the case supposed is ethereal resistance, and the moving body eliminating heat is in consequence of the rearrangement of its constituent particles adjusting themselves to their altered condition; and when this is attained the heated body must sink again to its normal condition of heat, and could not, I think, permanently retain a heat so much superior to the medium through which it moves, simply in consequence of resistance.

I am, Sir, most respectfully yours,

THOS. GALLASPIE.

[I am very glad to have my suggestions—I do not call them "views"—more fully discussed. Mr. Gallaspie however does not give any of the illustrations, with which he says chemistry abounds, of the *permanent* or rather long-continued production of light and heat by the slow condensation of *gaseous* bodies. Take oxygen and hydrogen. They combine with explosion. The heat, I conceive, which drove these particles apart whilst they were gases, has passed off into the air, and become motion acting upon the particles of the atmosphere. The resulting produce is a drop of water, not boiling. Shales and metals are solid substances; and even if we take metallic vapour, what should cause metallic vapour to exist in space? Where is the heat to come from anywhere except within the circuit of our earth's orbit, which should raise gold, iron, or even tin and lead into vapour. There seems to me not a particle of scientific evidence nor of probability in favour of the nebular *hypothesis*—such it was first properly termed, such it still, to my mind, remains.

The other point as to the effect of the resistance of the ether of space—although I do not agree with Mr. Gallaspie—is better put. The point raised by me was this: if the earth's motion in her orbit be due to any original impetus given to our planet, then the resistance of the ether of space to the earth's motion must give rise to friction, and this friction must be, by the laws of the correlation of the physical forces, be changed into some other force than motion. What is lost by friction as motion must become heat, light, electricity, chemical, or molecular action. As to what is the temperature of space, we have yet to learn what that temperature is in the area of the earth's orbit. Mr. Gallaspie should bear in mind that if this heat of our portion of space be due to the heat of the sun, it can be estimated. But certainly friction may raise a body, gaseous or solid, to, and maintain it at a higher temperature than the surrounding air or gaseous medium. The production of fire by a lucifer match, or the rubbing of two sticks together, shows this. If the heat produced by friction cannot be carried off by the conductivity of the atmosphere, it will be accumulated in the object. As the orbital speed of the earth is, on the spiral-orbit hypothesis, slowly and constantly diminishing, there should be thus consequently a slow and constant diminution of the heat acquired by the past accumulation from higher friction—that is practically a slight cooling of the globe throughout past ages, and at present going on. The amount of this would be negatived, outbalanced, or controlled by the inward tendency of the earth to nearer proximity to the sun. I regret much that space does not permit me to say more in this place.—S. J. MACKIE. *27th May*, 1864.]

COLONIAL GEOLOGY.

LEAVES FROM MY AUSTRALIAN NOTEBOOK.

BY THOMAS HARRISON, OF MELBOURNE.

NO. II.—THE EOCENE BEDS OF SCHNAPPER POINT.

To my mind, the very prettiest of Victorian watering-places is that known as above. It is so, not from brick-and-mortar embellishments, but because still left as made by nature. Nothing can be more striking than the contrast which this quietest of all quiet spots presents to the hurry and bustle incidental to the Victorian metropolis. Reaching the pier, a quaint-looking structure admirably matching the scenery around, one seems to have actually gone backwards twenty or thirty years in Australian history, and to be gazing on a scene such as Melbourne itself may have presented ere gold discoveries had revolutionized the colonies.

Even when regarded from the steamer, miles away, the view is especially prepossessing. Not distinguished by any very grand features; the hills swelling into gentle heights, thickly timbered and dotted at intervals with villa residences peeping from out lawn-like clearings; the cliffs of diverse colours, as formed by the wearing away of granitic or sandstone tongues of land; and the numerous little coves and miniature inlets, of which the doubling every fresh headland gives some novel view, form a bit of scenery half-countrified, half-maritime, as especially pleasing to the Australian, as are Herne Bay, Margate, or the Isle of Wight, to the London cockney.

Geologically, the district to be noticed forms a sort of irregularly-shaped basin, bounded on the north and south by the granitic masses of Mounts Martha and Eliza, on the east by a considerable patch of Silurian rocks, and on the west by the land-locked bay of Port Phillip; the whole having been filled up with Tertiary strata, of which the surface-rock is probably of the Pliocene period.

Two miles northerly from the pier, and at the foot of a spur running from Mount Eliza, a small bed of Carboniferous shales are plainly visible at low water. These contain fragments of plants peculiar to the Victorian Carboniferous period, which appears to have been not earlier than the Oolitic era. The situation of this small outlier gives the beds some little interest. Most of the Victorian coal-bearing rocks occupy a district forming a broad stripe some thirty miles wide, and extending from near Cape Otway to Gipps Land. Carboniferous strata crop out extensively around Geelong, and are known to exist, as underlying beds, over the whole peninsula of Bellarine (a district marked on the map by diagonal lines alternately dotted and black, and sloping towards the right); whilst the same strata, commencing on the eastern shores of Western Port, form the coal district of Cape Patterson, and run, with but few breaks, under the principal part of South Gipps Land. The question, therefore, naturally arises, as to whether the strata of Schnapper Point and Bellarine were not once continuous? If so, unless formed by denuding agencies, Port Phillip Bay must be the result of a fault of depression, caused, it may be, by the chasm left on the vomitting forth of vast quantities of basalt over the whole of south-western Victoria during the Tertiary period.

As bearing in some degree upon this subject, the sinking of the district, I may notice that the aborigines speak of a time when the river Yarra (the mouth of which is some fifteen miles north of the line forming the upper margin of the map), once ran on uninterruptedly to Bass Straits, the intervening portion of country being then dry ground. Such tradition of a depression having taken place during the human period scarcely accords with the observed facts of the land being still in process of elevation, and of the lower spots near Melbourne having been, until very lately, the bottom of estuaries. Peradventure, the story may be referred to another source. The entrance to the bay is exceedingly narrow, not much over two miles in width. The rocks on both sides are identical, and were probably at one time continuous. If this continuity existed for any lengthened period after the adjacent shores had arisen above high-water mark, it is evident the waters of the ocean would be shut out completely, and what is now the Bay of Port Phillip must have existed as a huge salt lake. No large rivers debouching into this, and numerous shoals existing in every portion, it is easy to conceive that the waters would grow gradually shallow, and that many spots would become dry land; the whole forming a large swamp, through the centre of which a chain of lakes might have stretched themselves to what is now the channel running between Points Nepean and Lonsdale, satisfying nearly every requirement of the aboriginal legend. The barrier separating the two waters might, in time, be broken through by waves and tempests. This done, the rush of tide during its flux and efflux would speedily form a channel; and the area, after having existed as a hunting-ground for the savage aboriginal inhabitants, would be transformed into a commodious harbour, sheltering the ships of a great and civilized nation.

The cliffs, and most part of the surface-rock of the Schnapper Point district, are of a somewhat modern Tertiary grit, identical with that found near Brighton; very ferruginous, occupied in many places by patches of lignite, but for the most part not highly fossiliferous, although in certain localities numerous conglomerated shell-beds are by no means of rare occurrence. To the wearing away of these upper Tertiary rocks into a precipitous coast-line, the watering-place owes its reputation for picturesque scenery; although, from their wide extent, and from the fact that the lower beds are covered up, the country immediately inland is rendered singularly uninteresting to a geologist.

At two spots, however, respectively two miles north and south of Schnapper Point Pier (one of them being closely adjacent to the Carboniferous beds previously alluded to), is a considerable outcrop of a much older stratum, generally pronounced to be Eocene, and contemporaneous with that upon which is erected the European capitals of London, Paris, and Vienna.

The southern of these outcrops is very prettily situated. For nearly two miles the upper and red cliff runs parallel with the coast, at a distance of some 200 or 300 yards inland; on the coast itself a second cliff is noticed, worn into the most fantastic forms, and between the two is an intervening valley, resembling in some slight degree, at certain points, the famous Undercliff of the Isle of Wight. The real or fancied similitude to the above well-known spot has, perhaps, induced many persons to refer the valley at Schnapper Point to the same origin as that giving rise to the features incidental to the southern coast of the "beautiful island." A very slight examination will show that this local theory is an erroneous one. The upper or ferruginous strata are comparatively friable and easily denuded, whilst the lower and Eocene beds are either compact argillaceous limestone, or clay of great tenacity. The coast rising—as the whole coast has certainly done—the upper beds would be eaten away more readily than the lower;

and whilst the lower thus stood out as a sort of terrace, some portions of the upper strata would be left undenuded thereupon, the old wave-washed rocks of a former period; hence the second cliff and its fantastic and highly picturesque configuration. This theory is strikingly borne out by the fact that, wherever these Eocene beds appear, there the terrace appears also, prominently noticeable, as is the outcrop of the gault from beneath the chalk all round the valley of the Weald of Kent, Surrey, and Sussex in England.

The beds referred to are evidently of considerable depth, although, from being situate but very little above the water-line, their extent downwards cannot easily be arrived at. The upper portion, for several yards in thickness, is composed of clay, seeming to have been re-deposited, and in which few, if any, fossils are met with. Immediately below this stratum is a great thickness of blue clay, in some places hardened into the compact argillaceous limestone before mentioned. Both as clay and as stone this bed is literally crowded with fossils, in a state of preservation quite startling to the stranger. Many of the shells retain their pristine colour, and look equally bright and perfect with those of the still living mollusca thrown upon the beach. Were it not for their strange and ancient shapes, it would be no easy matter to distinguish between these relics of an immensely distant age and shells of the present day. In state of keeping, the marine exuvial Eocene beds are infinitely better preserved than those which, found in the raised estuary deposits near Melbourne, are regarded as scarcely, if at all, anterior to the human period.

My own experience in searching for organisms among these Eocene strata, reminded me somewhat of a discovery made by the "Uncommercial Traveller,"—to wit, that "when at night one drunken man unaccountably turned up, another drunken man assuredly turned up soon after to keep the first company." What I noted being, that whenever I dropped upon a fine large specimen, I, without exception, dug up another or two close beside it. Not by any means, I should imagine, the result of chance, but that the shells rolling along an uneven sea-bottom would naturally fall into holes and hollows, and just as naturally be washed from off any elevated positions.

Nautili, cypridæ, conidæ, volutidæ, dentalia, cerithidæ, siliquariæ, muricidæ, and bryozoa, are very common, scarcely a square yard of ground being free from some of them, either perfect or in fragments. Among the cypridæ is that singular form *Cypræa eximia*, and others of gigantic dimensions.

The great quantity of tropical species, few, if any, of which are now discoverable in Victorian waters, suggest a variation of climate since the Eocene period in this part of the world, analogous to that remarked in the northern hemisphere. Nor is the great quantity of molluscous and echinodermatous, together with an almost total absence of crustacean and vertebral remains, less worthy of remark. Although the amount of life, according to the former types, must have been prodigiously developed during the period, but very few traces of any superior marine animals are discernible. In two hours, and within a space of barely twenty square yards, I dug out with a common spade from fifty to a hundred distinct species of shells, echinidæ, and corals; yet neither on the above nor any subsequent occasion have I there met with either crustacean or vertebrated remains. The absence of the latter is the more remarkable, seeing that the Cestracion, common enough in Australian waters, especially feeds upon shelly mollusca, and might therefore be expected to frequent a place whereat such particular food happened to be abundant.

A Victorian geologist (M. Blandowski), in a paper read before the Royal Society of Victoria, explains the absence of the above-named sub-kingdoms, by suggesting that the higher development and superior locomotive powers possessed by their various members, allowed of escape during the deposition of that muddy sediment completely enveloping the more sluggishly moving of their contemporaries. Such an hypothesis would of course involve a supposition of the muddy sediment having been suddenly deposited; a circumstance hardly reconcilable with the fact that the beds, where fossiliferous, appear to contain shells pretty equally distributed throughout a considerable thickness, and are not, as would result from a sudden deposition like that supposed, made up of a thick layer of unfossiliferous clay reposing upon a stratum of shells and organisms. Among the fossils, too, which I have by me, is a pecten, having an incrustation of bryozoa upon its inner surface—proof positive. I imagine that the shell must, after the death of its inmate, have lain during some time uncovered, or the growth of such parasite, in such position, could not possibly have taken place. And again, although every shell appears perfect and unworn by friction, yet in all conchifers and brachiopods the valves are disunited, and in univalves the operculum is invariably absent. If it is allowable to strain a point, I would suggest that previous convulsive movements had totally destroyed or greatly diminished the number of all the superior marine tribes in these waters; and that the lower classes, escaping the catastrophes by virtue of their less sensitive organizations, and subsequently multiplying greatly, simply that their enemies had been destroyed, had grown to be more than ordinarily numerous.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society.—*March* 9.—W. J. Hamilton, Esq., President, in the chair.

1. "On the Discovery of the Scales of Pteraspis, with some Remarks on the Cephalic Shield of that Fish." By Mr. E. Ray Lankester. The successive steps by which the genus Pteraspis came to be established, and the grounds on which the prevalent opinion as to its ichthyic nature rests, having been noticed, the author proceeded to describe in detail the scales,—which have lately been discovered at Cradley, near Malvern, and which alone were required to remove all doubt as to the affinities of the genus,—comparing them with those of Cephalaspis, to some of which they bear a great resemblance; and he concluded by giving a description of the markings on the surface of the cephalic shield of *Pteraspis rostratus*.

2. "On some Remains of Bothriolepis from the Upper Devonian Sandstones of Elgin." By Mr. G. E. Roberts. Remains of a large Dendrodoid Cælacanth obtained by the author in Elgin were referred by him to the genus Bothriolepis. These consisted of two large casts of a central head-plate, with portions of the test; a natural cast considered by him to represent the parietal, squamosal, scapular, and coracoid bones; casts of the nasal bones, and teeth of the upper jaw; together with tooth-like bodies, which were suggested to be teeth, originally situated in the posterior region of the mouth. The ornament borne upon the head-plate was next described by the author; and, in conclusion, the affinities between

the genera Bothriolepis, Asterolepis, Pteraspis, and Cephalaspis were discussed.

3. "On Missing Sedimentary Formations from Suspension or Removal of Deposits,—their general relations and importance." By Dr. J. J. Bigsby. In this paper the author brought together nearly all the known instances of gaps or blanks in the stratigraphical succession in different countries. Of the two formations which are in apposition through the absence of one or more formations, which thus constitutes a blank, Dr. Bigsby applied the term "Roof" to the upper, and "Floor" to the lower. He then described briefly the principal instances, arranging them according to the age of the formation constituting the "Roof," and drawing certain inferences from a consideration of them respecting the influence of oscillation of level, emergence, denudation, etc., in their production. In his concluding observations Dr. Bigsby observed that these gaps indicate that there always have been areas of dry land, and also showed that they prove the geological record to be, in places very much obscured, if not entirely obliterated.

Geological Society.—*March* 23.—1. "On some new Fossils from the Lingula-flags of Wales." By Mr. J. W. Salter.—Since the author's paper last session on the discovery of *Paradoxides* in Britain, the researches of Mr. Hicks have brought to light so many new members of the hitherto scanty fauna of the Primordial zone, that Mr. Salter was now enabled to describe two new genera of Trilobites, and a new genus of Sponge, and to complete the description of *Paradoxides Davidis*. He also remarked that the fauna of the Lingula-flags shows an approximation, in some of its genera, to Lower Silurian forms, and some—the shells and a cystidean—are of genera common to both formations; but the crustacea, which are the surest indices of the age of Palæozoic rocks, are of entirely distinct genera; and their evidence quite outweighs that of the other fossils. The Primordial zone is, moreover, in Britain separated from the Caradoc and Llandeilo beds by the whole of the Tremadoc group, at least 2000 feet thick. 2. "On the Millstone-grit of North Staffordshire, and the adjoining parts of Derbyshire, Cheshire, and Lancashire." By Mr. E. Hull and Mr. A. H. Green.—In this paper the Millstone-grit series was described, from the eastern edge of the Lancashire coal-field southwards to the coal-fields of North Staffordshire. After giving a general sketch of the geology of the district, and defining the upper and lower limits of the Millstone-grit, the authors explained a series of sections, running from east to west, at intervals across the country. In the most northerly of these the group consists of five thick gritstone-beds, separated by seams of shale, and attains a thickness of more than 2000 feet; while on the extreme south all but two of these beds have thinned away, and the whole thickness is there not more than 300 or 400 feet.

Between the base of the Millstone-grit and the Carboniferous limestone lies a group of shales and sandstones, with thin earthy limestones towards the bottom, which seem to hold the place of the Yoredale Rocks of Yorkshire. The mineral character of these beds was described, and their place noted on the sections.

A short notice was also given of two small in-liers of Carboniferous limestone, namely, at Moxon, east of Leek, and at Astbury, near Congleton.

Geological Society.—*April* 27.—1. "On the Geology of Arisaig, Nova Scotia." By the Rev. D. Honeyman.—A careful examination of the country in the neighbourhood of Arisaig enabled the author to construct three sections and a map, showing the geological constitution of the district. Two of these sections were nearly parallel to one another, running from north to south, and taken some distance apart, while the third was nearly at right angles to the other two; thus a tolerably accurate idea of the geology of the country could be obtained. The author described each of these sections in detail, giving lists of the fossils found in the different beds, which proved them to be of Upper Silurian age; and he further considered that they justified the adoption for the subdivisions of these Nova-Scotian Silurians of the terms May-hill, Lower Ludlow, Aymestry, and Tilestones, the first and third of which had been used for them previously by Mr. Salter. Besides Silurian rocks, there occurs in the western part of this district a conglomerate of Lower Carboniferous age, while trap-rocks occur on the north and south.

2. "On some Remains of Fish from the 'Upper Limestone' of the Permian Series of Durham." By Mr. J. W. Kirkby.—The object of this paper was to record the discovery of fish-remains in the upper magnesian limestone of the Permian formation, which is higher in that series than any vertebrate remains had been previously known to occur. The strata exposed in the quarries were described in detail, especially the bed from which most of the fish were obtained, and which is known as the "flexible limestone."

The author stated that at least nine-tenths of the specimens belong to *Palæoniscus varians*, the remainder belonging to two or three species of the same genus, and to a species of *Acrolepis*. Detailed descriptions of the different species of fish were given, as also were short notices of the species of plants sometimes found associated with them, one of which he believed to be *Calamites arenaceus*, a Triassic species. The occurrence of *Palæonisci* with smooth scales was stated to be antagonistic to Agassiz's conclusion, that the Permian species of that genus have striated, and the Coal-measure species smooth scales. In conclusion, Mr. Kirkby remarked that the fauna of the period appeared to have an Estuarine facies, and he expressed his opinion that the fishes were imbedded suddenly, as a result of some general catastrophe.

3. "On the Fossil Corals of the West Indian Islands. Part 3: Mineral Condition." By P. Martin Duncan, M.B.—The results of the process of fossilization, as seen in the West Indian fossil corals, being very remarkable, and having much obscured their specific characters, thus rendering their determination extremely difficult, Dr. Duncan found it necessary to thoroughly examine their different varieties of mineralization, and to compare their present condition with the different stages in the decay and fossilization of recent corals as now seen in progress. Thus the author was enabled to show the connection between the destruction of the minuter structures of the coral by decomposing membrane and certain forms of fossilization in which those structures are imperfectly preserved; and he likewise stated that the filling-up of the interspaces by granular carbonate of lime and other substances, as well as the induration of certain species, during a "pre-fossil" and "post-mortem" period, gave rise to certain varieties of fossilization, and that the results of those operations were perpetuated in a fossil state.

The forms of mineralization described by Dr. Duncan are—Calcareous; Siliceous; Siliceous and Crystalline; Siliceous and Destructive; Siliceous

Casts; Calcareo-siliceous; Calcareo-siliceous and Destructive; Calcareo-siliceous Casts.

In describing these forms especial reference was made to those in which the structures were more or less destroyed during the replacement (by silica) of the carbonate of lime which filled the interspaces, and during that of the ordinary hard parts of the coral.

In explaining the nature and mode of formation of the large casts of calices from Antigua, the author drew attention to the fact that the silification is more intense on the surface and in the centre of the corallum than in the intermediate region; and, when examined microscopically, it could be seen that the replacement of the carbonate of lime began by the silica appearing as minute points in the centre of the interspaces and of the sclerenchyma, and not on their surface. In conclusion, the relation of hydrated silica to destructive forms of fossilization was discussed, together with the influence of all the forms enumerated above in the preservation of organisms, and as one cause of the incompleteness of the geological record.

May 11.—1. "On a Section with Mammalian Remains near Thame." By Mr. T. Codrington, F.G.S.—A railway-cutting through a hill between Oxford and Thame having exposed a section of certain gravel-beds, from which many mammalian remains were collected, the author now gave a short description of the section, and a list of the bones he had obtained from it. The hill is nearly surrounded by the Thame and two small tributaries, and consists of Kimmeridge clay capped by a bed of coarse gravel overlaid by sandy clay. The gravel consists of chalk-flints, pebbles derived from the Lower Greensand, and fragments of mica-schist, etc., indicating a northern-drift origin; it contained many bones of Elephant, Rhinoceros, Horse, Ox, and Deer, and a single phalanx of a small carnivore, but no flint implements were discovered.

2. "On a Deposit at Stroud containing Flint Implements, Land and Freshwater Shells," etc.* By Mr. E. Witchell, F.G.S.—In the construction of a reservoir near the summit of the hill above the town of Stroud, the author observed, about two feet from the surface, a deposit of tufa containing land-shells, with a few freshwater bivalves; in it he subsequently discovered several flint flakes of a primitive type, and in the overlying earth a few pieces of rude pottery. As the deposit is situated on the spur of a hill nearly separated from the surrounding country by deep valleys, and as Mr. Witchell considered it to be comparatively recent, he concluded that it had been formed in a pond or lake, which had been caused by a landslip from the higher ground producing a dam that stopped the downflow into the valley of the water of the neighbouring springs.

3. "On the White Limestone of Jamaica, and its associated intrusive rocks." By Mr. A. Lennox, F.G.S.—The White Limestone of Jamaica was described as including a basement series of sandstones and shales, a hard white limestone, a yellowish limestone, and an uppermost member consisting of dark-red marl; it was estimated to be at least 2500 feet thick; and the author stated that, at the junction of the calcareous rocks with the granite, the former was often more or less altered, and this appeared to be the best proof of the Tertiary age of the latter. Mr. Lennox then adverted to a diagram-section of the rock-formations of Jamaica by the late Mr. Barrett (Quart. Journ. Geol. Soc. vol. xix. p. 515), which he con-

* Described already by Mr. John Jones, of Gloucester. See 'Geologist,' Vol. VI. p. 307.—Ed. Geol.

sidered erroneous on the following grounds:—(1) he knows no section in Jamaica in which the relation of the White Limestone to the Hippurite-limestone is seen; (2) the White Limestone he believes to be of Miocene age; and (3) the shaly and sandy beds represented in the section as overlying the White Limestone he considers to be undoubtedly in infra-position. The author then discussed the question of the age of the White Limestone, first on physical grounds, and afterwards palæontologically, inferring that it was decidedly of Miocene date; and in conclusion he remarked that the White Limestone had probably been deposited slowly in a tranquil sea, and discussed its relation to the Tertiary beds of the other West Indian Islands.

4. "Facts and Observations connected with the Earthquake which occurred in England on the morning of the 6th of October, 1863." By Fort-Major T. Austin, F.G.S.—Earthquakes in the British Isles attract usually but little notice, owing probably to the mild form in which they generally occur; but that one treated of in this paper, owing to its greater violence, aroused attention to the subject. The disturbance was said to extend from a point in St. George's Channel forty or fifty miles to the north-west of Pembrokeshire to Yorkshire, and the focus of the disturbance to be situated near the former spot. The author brought forward a number of facts for the purpose of proving the intensity of the shock, the time at which it occurred, the number of vibrations, their direction (which was considered to be from W.N.W. to E.S.E.), and the occurrence of incidental phenomena, and concluded by passing in review the natural causes competent to produce these and other characteristics of earthquakes.

NOTES AND QUERIES.

THE MEASUREMENT OF HEIGHTS BY THE ANEROID.—The following explanation of the use of the aneroid in taking heights is given by Mr. Spencer Browning, of the Minories, in a pamphlet published by him. His aneroids, especially his mountain- and small pocket-instruments, are unequalled for finish and accuracy.

The *theory* on which the measurement of heights is effected by the barometer, the aneroid, or the sympiesometer, is exceedingly simple, though the *application* of the theory depends on formulæ which have required mathematical skill to construct, and which include "constants" obtained by delicate experiment.

Theory.— Let m and m' be two stations on a mountain side: required to find the difference of elevation between them.

The aneroid (or barometer or sympiesometer) having been corrected for the effect of temperature upon *its own mechanism*, shows at m the weight of a column of air, having the vacuum box of the instrument for its base, and reaching from m to the extreme limits of the atmosphere. Similarly, an observation at m' gives the weight of the upper portion of an identical column of air, reaching from m' to the limits of the atmosphere.

Consequently the excess of pressure at m above that at m' gives the weight of that part of the column which extends from the level of m to the level of m'.

Knowing the weight of the column, if we also ascertain the specific gravity of the air that composes it, we have data for calculating its *height*.

To learn the specific gravity of the column, two main influences have to be taken into account. There are also secondary ones, of so little importance that we shall not notice them here.

(A) The specific gravity of the air, other circumstances being the same, bears a definite ratio to the pressure it sustains; that is, the greater the pressure, the more it is condensed and the more does a cubic foot of such condensed air weigh. The lower strata of the atmosphere are therefore denser than the higher.

(B) The specific gravity of the air, other circumstances being the same, is greater in proportion to its coldness. Air that is cold weighs more than air that is hot.

Formula.—These principles are simple enough. Experiments made with extraordinary care have shown the *amount* of the above influences, and the *laws* by which they act. Mathematicians, and notably La Place, have thrown the whole into a formula conveniently adapted for computation. It is substantially as follows, in which the letters A and B refer to the paragraphs (A) and (B), and S represents the secondary considerations, from which we abstain:—

$$\text{The height of } m' \text{ above } m = (A_{m'} - A_m) \times \{1 + B + S\}.$$

The calculation of the weight of a column of air, reaching to the limits of the atmosphere, on the principle (A), for all pressures of the barometer, at intervals of $\frac{1}{100}$th of an inch, has been made, and forms, in some modified shape, the *first* of the usual barometric tables.

Browning's new aneroids, besides being graduated to inches of barometric pressure, are also graduated according to the length of the column, determined on the principle (A); the starting-point having been so taken, that when the barometric pressure is 30 inches, the graduation marks 0 feet. The graduation is always made on the assumption of the temperature of the air being 32° Fahr. A_m is the graduation that would be indicated, under that hypothesis, at the station m, and $A_{m'}$ that at m'.

To correct these results on the principle (B), the temperature of the air is observed at m and again at m'. The mean of the two temperatures gives at least an approximation to the mean temperature of the entire column of air. The excess of this mean temperature above 32°, divided by 450 (one of the constants that have been determined by experiment), forms B.

In other words, if t be the temperature at m, and t' at m',

$$B = \frac{(t - 32^\circ) + (t' - 32^\circ)}{2} \times \frac{1}{450} = \frac{t + t' - 64^\circ}{900}.$$

Hence the first and the important part of La Place's formula is—

$$(A_{m'} - A_m) \times \left\{1 + \frac{t + t' - 64}{900}\right\}.$$

Example I.—Suppose a single traveller to wish to take the height of a mountain, m', above the valley, m. He observes at m, before starting, that his aneroid points, say to 450 feet, and his thermometer to 50° Fahr. On reaching the top of the mountain m', he finds his aneroid to give 9560 feet, and his thermometer to be 40° Fahr.

$$\begin{array}{rl} \text{then } A_{m'} = & 9560 \\ A_m = & 450 \\ \hline A_{m'} - A_m = & 9110 \\ & 260 \\ \hline \text{True height of } m' \text{ above } m. & 9370 \end{array} \qquad \begin{array}{r} t = 50 \\ t' = 40 \\ \hline t + t' = 90 \end{array}, \text{ and } \frac{t + t' - 64}{900} = \frac{26}{900}$$

$$9110 \times \frac{26}{900} = 260$$

If there were two observers, they would of course work simultaneously, one in the valley and the other on the hilltop, to guard against such material change of temperature or pressure as might take place while a single traveller was climbing.

Example II.—If the traveller desire to know his elevation above the sea and has no simultaneous observations to refer to, he must *assume* the pressure at the sea-level to be at its average, viz. 30 inches, and make the best guess he can at what would be the temperature of the air; the temperature decreasing, on a rough average, 1° for each 300 feet elevation. Let us suppose it in the above case to be 52°; then the height of M_1 above the sea is thus worked out:—

$$\begin{array}{l} t=52 \\ t'=40 \\ \hline t+t'=92 \end{array} \text{ and } \frac{t+t'-64}{900}=\frac{28}{900}$$

$$A_m - 0 = 9560$$

$$\text{Height of } M_1 \text{ above sea} \left\{ \begin{array}{r} 308 \\ \hline 9868 \end{array} \right. \quad 9560 \times \frac{28}{900} = 11 \times 28 \text{ about } = 308$$

The following tables refer to S, and explain themselves. They are the only ones that have to be applied to an aneroid or to a sympiesometer:—

TABLE I.

Correction for the difference of gravity in various latitudes. Correction positive from lat. 0° to 45°, negative from 45° to 90°.

Approximate difference of level.	Latitudes. 0° / 90	10° / 80	20° / 70	30° / 60	40° / 50
1,000...	3	2	2	1	1
5,000...	13	12	10	7	2
10,000...	26	24	20	13	5
15,000...	39	37	30	20	7
20,000...	52	49	40	26	9

TABLE II.

Table for decrease of gravity in a vertical, acting on the density of the air—always *additive*.

Approximate difference of level.	Height of Aneroid at Lower Station. inches. 16 / feet. 16,000	inches. 20 / feet. 10,000	inches. 24 / feet. 6,000	inches. 28 / feet. 2,000
	feet.	feet.	feet.	feet.
1,000...	2	1	1	0
5,000...	8	5	3	1
10,000...	16	10	6	2
15,000...	24	15	8	3
20,000...	31	20	11	3

The aneroid may be briefly described as follows:—

The weight of a column of air, which in the ordinary barometer acts on the mercury, presses in the aneroid on a small round German-silver box, both surfaces of which are corrugated in concentric circles, to improve the elasticity of the metal. The indications are thus obtained without the use of mercury or any other fluid.

The new aneroid, which has been so favourably received and extensively patronized by members of the Alpine Club, is the result of a series of experiments carried on continuously for several years. The first point accomplished was the perfect compensation of the instrument for temperature. This was effected by introducing a compound bar of steel and brass to form one of the levers which transmits the movements of the vacuum chamber to the hand. For this important improvement a prize-medal was awarded to Spencer, Browning, and Co., in 1862.

Mr. Browning's aneroids possess the following advantages:—

1st. They are most carefully corrected for temperature, from about 30° to 100° Fahrenheit, by compound bars of metal, on the principle of the chronometer balance-wheel.

2nd. They are divided by actual comparison with a Kew *verified* gauge, every inch varying in length: other makers mark an equal scale on the dial, and endeavour to regulate the works so that the movement shall correspond. Any scientific person will soon see that this is a mechanical impossibility.

3rd. They have vacuum boxes made of fine hard-tempered gold, which impart the property to them of returning closely to their zero after experiencing a change of pressure of 16 inches.

4th. They have the centre pivots jewelled, to diminish friction as far as possible: greater sensitiveness is thus obtained, and from the more accurate fitting of the centre staff, the instrument is not so liable to change its zero in travelling.

A card, with a table of the index errors of the instrument, is given with each aneroid; or the instrument will be sent to Kew for verification upon payment of 5*s*., if a fortnight's time can be given.

When an aneroid has changed its zero, it has been customary to correct it by turning a screw at the back of the instrument, which acts through the medium of the mainspring on the vacuum chamber.

This, however, is attended with two rather serious objections:—1st, it alters the tension of both the mainspring and the vacuum chamber, which do not settle down for some time; and, 2nd, *it alters the range of the whole instrument.*

These objections can now be obviated by a beautiful but simple contrivance, suggested to Mr. Browning by Francis Galton, Esq., F.R.S. This consists in making the dial turn round on the barometer case. By this arrangement the instrument is readily corrected by turning the dial until the required division comes under the pointer.

These aneroids should be held in a horizontal position while being read, and *not tapped* previous to taking an indication.

Tertiary Mammalia and Shells.—The Tertiary beds of Madrid contain, according to Messrs. Sullivan and O'Reilly, bones of *Anoplotherium Paleotherium, Antelope, Cervus, Sus, Rhinoceros, Hippopotamus, Mastodon.* The Tertiary dolomitic limestone near Guadalaxara is often completely full of the shells of *Limnæa planorbis, Paludina, Helix*, etc.

Errata in Fossil Birds.—The following corrections in the references to the Plates require to be made:—At page 18, line 12, *for* "see Pl. IV.," *read* see fig. 2, Pl. III.; line 13, *after* ("fig. 115") *insert* see Pl. IV. fig. 3; at page 23, second line from bottom, *for* "Pl. V.," *read* Pl. XII. It will be desirable, throughout the entire series of papers, to refer to the figures in the Plate by the notations given in the Explanation of the Plates at page 233, rather than by those given in the articles, as some errors have occurred.—S. J. M.

Errata.—Page 87, last paragraph, *for* "*R. Ungeriana;* and Reuss's *R. ammonoides,*" read "*R. Ungeriana*, and Reuss's *R. ammonoides;*" it not being intended to liken the last to *R. Akneriana* next mentioned.

FOSSIL FLORA OF THE ROTHLIEGENDEN IN BOHEMIA.

BY FRANZ POSEPNY.

	Genera and Species.	Jokély's Divisions. Lower.	Middle.	Upper.	Localities.	Authorities.
	ACOTYLEDONES.					
	Algæ.					
1	Spongilopsis dyadica, *Gein.*	·	·	*	Huttendorf and Oberkalna	Geinitz, Dyas, p. 336.
2	Zonarites digitatus, *Brongn.* sp.	·	·	*	Oberkalna	D. Stur.
	Equisetaceæ.					
3	Calamites communis, *Ettg*	·	·	*?	Peklov	D. Stur.
	Asterophyllitæ.					
4	Annularia longifolia, *Brongn*	*	·	·	Podhor	Jokély, 1861, p. 382.
5	A. sphenophylloides, *Zenk*	·	·	*	Kostálov	D. Stur.
6	A. carinata, *v. Gutb.*	·	·	*?	Peklov	D. Stur.
7	Volkmannia gracilis, *Sternbg.*	·	·	*?	Peklov	D. Stur.
8	V. distachya, *Ettg.*	·	·	*?	Peklov	D. Stur.
9	V. polystachya, *Sternbg*	·	·	*	Kostálov	Jokély, p. 382.
	Filices.					
10	Sphenopteris bipinnata, *Mün. ?*	*	·	·	Kozinec	D. Stur.
11	Hymenophyllites semialatus, *Gein.*	·	·	*	Kalna	D. Stur.
12	Odontopteris obtusiloba, *Naum.*	·	·	*?	Peklov	D. Stur.
13	Neuropteris tenuifolia, *Sternbg.*	*	·	·	Nedocz and N. von Podhor	Jokély, 1861, p. 382.
14	Cyatheites arborescens, *v. Schl*	*	·	·	Stepanic	Geinitz, Dyas, p. 338.
		·	·	*	Hennersdorf & Huttendorf	" " "
		·	*	·	Ottendorf	" " "
15	C. Oreopteridis, *Göpp.*	*	·	·	Nedvez and Podhor	Jokély, 1861, p. 382.
				*?	Peklov	D. Stur.
16	C. confertus, *Sternbg.* sp.	·	·	*	Hennersdorf & Huttendorf	Geinitz, Dyas, p. 338.
		·	·	*	Kostálov	D. Stur.
		·	*	·	Ottendorf	Geinitz, Dyas, p. 338.
17	Alethopteris pinnatifida, *v. Gutb.* sp.	*	·	·	Hermannseifen	" " 339.
18	A. Cistii, *Brongn.* sp.	·	·	*?	Peklov	D. Stur.
19	A. Gigas, *v. Gutb.* sp	·	·	*?	Peklov	D. Stur.
20	Tæniopteris abnormis, *v. Gutb*	·	·	*	Oberkalna	Geinitz, Dyas, p. 339.
21	Partschia Brongniarti, *Sternbg*	*	·	·	N. von Podhor	Jokély, 1861, p. 339.
22	Psaronius infarctus, *Ung.*	·	*	·	Neu-Paka	Geinitz, Dyas, p. 339.
23	P. helmintholithus, *Cotta*	·	*	·	Neu-Paka	" " "
24	P. Zeidleri, *Corda*	·	*	·	Neu Paka	" " "
25	P. Haidingeri, *Stenzel*	·	*	·	Neu-Paka	" " "
26	P. asterolithus, *Cotta*	·	*	·	Neu-Paka	" " "
	Lycopodiaceæ.					
27	Walchia piniformis, *v. Schl.* sp.	*	·	·	Stepanic	" " "
	(Lycopodites Bronnii, *v. Schl.* sp.).	·	·	*	Oberkalna and Huttendorf.	" " "
		*	·	·	Kozinec	D. Stur.
		·	*	·	Ottendorf	Geinitz, Dyas, p. 339.
	MONOCOTYLEDONES.					
	Palmæ.					
28	Guilielmites umbonatus, *Sternb.* sp.	·	·	·	Böhmen	Geinitz, Dyas, p. 340.
	DICOTYLEDONES.					
	Cycadeæ.					
29	Pterophyllum Cottæanum, *v. Gutb.*		·	·	Peklov	D. Stur.
	Nöggerathieæ.					
30	Cordaites Ottonis, *Gein*	*	·	·	Hohenelbe	Geinitz, Dyas, p. 341.
31	Nöggerathia palmæformis, *Göpp*	*	·	·	Stepanic	" " "
32	Cyclocarpon	*	·	·	Stepanic	" " "
		*	·	·	Waltensdorf	" " "
	Coniferæ.					
33	Araucarites cupressus, *Göpp*	*	·	·	Kozinec	Jokély, 1861, p. 393.
34	A. Cordai, *Ung.*	·	·	*	Kostálov	" " 382.
35	A. Schrollianus, *Göpp.*	·				
			*		Pecka	" " 394.
36	A. Agordicus, *Ung.*	·	·	·	Malotic, near Böhm.-Brod.	
	Sigillarieæ.					
37	Sigillaria, sp	·	·	*	Huttendorf	Geinitz, Dyas, p. 343.

Current Classification of Fossil Sponges.—The following classification, certainly very erroneous, appears to be, as nearly as may be, that which is current amongst British geologists. The Editor would be much obliged by communications as to proposed and necessary amendments.

I. Ocellaridæ.

Coscinopora.
Guettardia.
Ventriculites (*Ocellaria*).
Brachiolites.
Cephalites (*Cribrospongia; Tragos*, Goldfuss, non Schweg.).
Cœloptychium.
Retispongia.
Thalamospongia.
Palæospongia.
Porospongia.
Goniospongia.

II. Siphonidæ.

Eudea (*Scyphia*).
Perispongia.
Camerospongia.
Verticillites.
Cnemidium.
Siphonia (*Halirrhoa; Polypothecia*).
Hippalimus (*Scyphia*).
Choanites.
Jerea (according to *Morris*).
Paramoudra.

III. Lymnoreidæ.

Lymnorea.
Tremospongia.
Leiospongia.
Actinospongia.
Rhizospongia.
Mammillopora (*Lymnorea*).

IV. Sparsispongidæ.

Chenendopora (*Manon*).
Forospongia.
Jerea (according to *D'Orbigny*).
Marginospongia.
Pleurospongia.
Hemispongia.
Verrucospongia (= *Manon*).
Sparsispongia (= *Stromatopora*).
Stellispongia.

V. Amorphospongidæ.

Cupulospongia.
Plocoscophia.
Meandrospongia.
Amorphospongia (*Achilleum*).
Turonia.
Strematopora.
Spongia.

VI. Halichondridæ.

Cliona (*Vioa; Entobia*).
Halichondria.
Thoosa.
Spongilla.
Alcyonella.
Geodia.
Tethya.
Grantia (*Leucalia*).
Dunstervillia.

VII. Clionidæ.

Cliona.
Talpina.

VIII. Uncertain.

Conis.
Coscinopora.
Steganodictyum.
Udotea.
? Steganodictyum.
Stromatopora.

Intimations from collectors as to the collections they have formed, would also especially oblige.—S. J. M.

Coal-beds of the Nottingham Collieries.—*Eastwood Colliery.*—The coal is of excellent quality, free from dust, throwing out great heat; durable and clean in burning, and said to be very superior for general household purposes. *Watnall, Beauvale, and Brinsley Collieries.*—The "Comb Coal," the highest workable seam, is 2 feet 6 inches thick, and is used for household purposes in the midland counties of England. It is a free and bright burning coal, leaving a small quantity of red ashes. *Eastwood and Codnor/Cossall? manhay Collieries.*—The deep soft coal is most extensively worked for household purposes; it is about 180 yards below the "top hard coal," and about four feet thick. The markets for this coal are London and most of the counties south of Derbyshire. It is free burning, leaving a small quantity of brown ashes. The "bottom hard coal" is about 20 yards below the deep soft coal, and is 3 feet 6 inches thick. It is used extensively for locomotive purposes by the London and North-Western, Midland, Great Northern, and other railways in England. It is also used for general steam purposes. In the midland counties it is extensively used for iron-making. Like the top hard coal, it burns without clinker, and will bear exposure to any atmosphere for years without deterioration. It is procured in large blocks. The evaporative power in ordinary working of a locomotive is nearly 7lb. of water for 1lb. of coal consumed. *High Park, Beggarlee, Underwood, Watnall, and Old Brinsley Collieries.*—The "top hard coal," one of the highest workable seams in Derbyshire and Nottinghamshire, is 5 feet thick, and is used extensively for locomotive purposes by the London and North-Western, Midland, and other railways in England. It is also used for steam navigation, and is one of the purest and best iron-making coals. It burns without clinker, and bears exposure to any atmosphere for years without deterioration. It is procured in large blocks without small, and is generally preferred for household purposes in the counties of Lincoln, Rutland, and Leicester. The evaporative power in ordinary working of a locomotive is 7lb. of water for 1lb. of coal consumed.

An Earthquake in Sussex.—Shortly before midnight on the 30th of April last, a curious phenomenon was experienced at Maresfield, Sheffield Park, Fletching, Chailey, and the neighbourhood, and which has been attributed to the shock of an earthquake. As may very naturally be supposed, the occurrence created some degree of alarm at the time, and has since formed the subject of general conversation in the part of the county where it was experienced. The shock seems to have been confined to a somewhat limited area, and is fortunately unaccompanied by any serious results. It was, no doubt, generally felt about the same moment, and although the difference of a few minutes has been stated at various places, this circumstance is probably owing more to the variation of the time as recorded by the owners' timepieces than to any actual difference. At Maresfield, the phenomenon was experienced at nine minutes past eleven, and is described in a letter from Captain Noble as an extraordinary vibration lasting fifteen seconds, and shaking the doors, windows, and beds at Maresfield Lodge with some violence. The oscillation and vibration were likewise generally felt throughout the parish. At Sheffield Park, the seat of the Earl of Sheffield, the earthquake was felt by the members of the noble earl's family and household. The time recorded here is six minutes past eleven. Among other indications the butler heard the mortar fall behind the wainscot, and a loose bar attached to a window-shutter oscillated and struck the shutter. Lord Pevensey and Mr. Douglas Holroyd, who were at Sheffield Park, distinctly felt the shock. At Scaymes Hill, it is stated that the bells at the public-house distinctly vibrated; while at Fletching, the family of Mr. Jones were disturbed by a rumbling noise. Similar sensations were experienced at Buckham Hill and at Chailey—more especially at two cottages at the latter place, where the shock seems to have been more severely felt. Writing from Maresfield to the 'West Sussex Gazette,' Captain Noble says:—"It may be worth while to record a curious phenomenon observed at Maresfield last night (April 30th), inasmuch as, after our experience of the 6th October ult., it may very probably be referable to an earthquake. About 11 h. 9 m. G.M.T., an extraordinary vibration was felt here, lasting, as nearly as I can gather, some fifteen seconds, and shaking the doors, windows, and beds in this house with some violence. Most curiously, I felt nothing of it myself, but several of my servants left their beds in alarm. One of the ladies of my family describes the sensation she experienced as that of having her bed moved to and from the wall against which its head stands, as though some one had got underneath it and were trying to lift it. As the bedstead in question stands nearly S.E. and N.W., this may serve to give an idea of the path of the earthquake-wave, if such it were. I learn from various sources that this oscillation and vibration were felt all over the parish. Finally, three of my female servants were again alarmed some time after midnight by a rushing sound, as though of violent hail, passing close to their windows, although, on looking out, nothing was visible, nor has either hail or rain fallen here since the 28th ultimo." [It has been reported that a second shock was felt soon after midnight, but not so forcible as the first.] In the town of Lewes, it appears, the shock was distinctly felt. One lady states that while speaking to her servant in the kitchen, a few minutes after eleven o'clock, she heard a sudden shaking of the front door and windows, the unusual violence of which greatly alarmed the servant girl. Thinking the shaking noise was occasioned by the return of her husband, who had been out upon some business, the servant went to look, and was surprised to find that no one had entered. As the house stands in close proximity to the railway, and is frequently shaken by the motion of passing trains, this violent agitation of the door and windows was at the time attributed to this cause. Shortly after midnight, when this lady had retired to rest, she states that she heard a peculiar and rushing sound, as if of hail or rain being forcibly driven against the windows. Many persons supposed there must have been a serious explosion of gunpowder somewhere, and one gentleman says, "I was sitting reading on the ground-floor at the time, and my chair quite shook under me." The shock does not appear to have been attended with serious consequences of any kind.

THE GEOLOGIST MAGAZINE.—Future communications respecting 'The Geologist' should be addressed to Mr. Mackie, 25, Golden Square. Back numbers and volumes previous to 1862 may be obtained of Mr. Gregory, 25, Golden Square, W. Remittances and applications for Vols. V. VI. and VII. are to be made to the present publishers, Messrs. Reeve and Co. —ED. GEOL.

REVIEWS.

Notes on the Geology and Mineralogy of the Provinces of Spanish Santandar and Madrid. By W. K. Sullivan, Ph.D., and J. P. O'Reilly, C.E. London: Williams and Norgate. 1863.

As very little is generally known of Spanish geology, every contribution that makes us better acquainted with what must be an interesting country is more than usually acceptable. The volume before us is composed of papers originally printed in the 'Atlantis' (vol. iv.), and relates chiefly to minerals and mining-matters. It is, however, abundantly illustrated with maps, views, and sections, and gives a good deal of information of the stratified deposits of the district between the Bay of Santandar and the river Deva. It commences with an outline sketch of the physical geography of the province of Santandar, an area some 60 miles by 25, and an outline of the geology. Mountain-chains are its dominant physical feature, the southern boundary resting on the Cantabrian chain. The centre and south-west of the province are occupied, according to the authors, by two groups of rocks; one, the most massive, and constituting some of the highest peaks of the south-west, is represented chiefly by a limestone remarkably jagged in its outlines, hard and splintery, generally white externally, where exposed, but greyish internally, and often almost black in its lowest part. At its base this limestone seems to be associated with a hard grey sandstone rock, and both rest unconformably on thick beds of slate-clay. Beds of conglomerate, formed chiefly of quartz pebbles, with an extremely hard siliceous cement, are associated with the slate-clay. The limestone rocks appear very much upheaved, and the strata are of the nearly vertical, and forming a succession of anticlinals, the general strike of which may be taken as E. a few degrees W.

The second group of rocks consists of beds of variegated clays alternating with soft sandstone beds of slate-clay, thin beds of marly limestone of a dark grey colour alternating with thin layers of black marly clay. The predominating colour of the sandstones is red. The limestone rocks, upon which the beds of clay, sandstone, etc. rest, rise to the south and south-west in the lofty mountains of the Picos de Europa.

After detailing with full particulars numerous sections, the author attempt to summarize and deduce the stratigraphical succession and relative ages of the different rocks. To do this, they first take such horizons as are naturally sufficiently definite. The nummulitic series offers one which is not only convenient as the newest or uppermost, but is also topographically the first, being near the sea-shore. The nummulitic rocks rest on cretaceous beds, which occupy a narrow band of country near the sea, in the west of the province, and become largely developed towards the east. Those on the north side of the Bay of Santandar have been studied by M. de Verneuil, who considers the beds lying between the Bay and the lighthouse to belong to the Upper Chalk Marls, and the authors sufficiently establish their position as the first horizon below the nummulitic beds. Those beds which form the quay of Santandar strike off towards the west, and are found not only to overlie the dolomite of Peña Castillo and the immense mass of the same rock lying about the south-west of the Bay of Santandar, but may be traced along the coast up to San Pedro, and inland to Reocin and La Florida. This dolomite is in some places 120 mètres thick. The beds which underlie contain *Calamophyllia Stokesii, Rhynchonella rimosa, Ostrea deltoidea, Photodomya lyrata, Ammonites bifrons, Ammonites serpentinus*. Pectens and belemnites are seven, which are undoubtedly jurassic, while in the dolomite itself ammonites similar to those of the underlying beds. The authors therefore put this dolomite at the top of the jurassic series, and make of them a second well-defined horizon.

About the upper boundary there can be no difficulty, but it is otherwise with the lower limits. Beneath the dolomite are a series of beds of hard shelly argillaceous limestone, with variegated clay-beds passing into reddish-grey sandstone, beneath which are thick beds of red micaceous sandstone; next follow the beds of compact blue or black limestone, containing metalliferous deposits, and forming the axis of the east and west chain called the Dobra. Beyond Monte Dobra, in the valley of Los Corrales, there is a repetition of the thick beds of red sandstone. In the upper members of this series many jurassic fossils have been found; but, according to the authors, none at all in the great beds of red sandstone; hence the question, are all these beds jurassic, or does the red sandstone represent an island of the Trias? The authors incline to the opinion that all the rocks between the dolomite and the Dobra are jurassic, including the Dobra limestone itself. If the Dobra limestone be jurassic, the authors contend that the eastern part, if not the whole of the Cantabrian chain, which reach 2600 feet, are likewise jurassic; and that the conclusion then is inevitable, that the jurassic formation extends into the province of the Asturias, and that the whole of the geology of the eastern part of that province requires rectification.

After the geology, the third part of the book is devoted to the geognostical relations of the more important metalliferous deposits, and the fourth to the mineralogical structure and chemical composition of the ores, with some remarks upon their mode of production; and finally, we have chapters on the deposit of sulphate of the soda in the valley of Jarama, near Aranjuez; on the chemical composition of a lacustrine dolomitic limestone in the neighbourhood of Madrid; and on some curious molecular changes produced in disilicate of zinc and some of its compounds with carbonates by the action of heat. This work is well worthy of the attention of geologists.

Geological Essays, and Sketch of the Geology of Manchester and the Neighbourhood. By John Taylor. London: Simpkin, Marshall, and Co. 1864.

It is refreshing to take up a book on Geology in which we find ourselves free from the set phrases and pratings of the old school of geologists, or the hackneyed and tiresome inveighings against the hard words of science, so common in the multitude of works on so-called popular science. Of geological nomenclature, at least, Mr. Taylor takes a more sensible view than most of his "popular" contemporaries, and he at least considers geological classification as the grammar of geology, without which—

"The student could no more make headway than he could read Horace or Virgil without having first learned to construe in Latin." "Nomenclature," continues Mr. Taylor, "is the 'slough of despond,' through which every man must wade ere he can cultivate the acquaintance of any science whatever. It is the Cerberus which guards the gates of its under-mysteries, the cipher whose knowledge unfolds the gathered wisdom of centuries; aft r this difficulty has been overcome, no man will stand up more for its utility or find it more serviceable than he who at first sight was about to turn away with mingled feelings of disgust and despair; and although such a classification is anything but perfect, and by no means to be relied upon as infallible, it serves as a clue to the mode of natural operations in bygone epochs. In short, its utility may be seen by the fact that it has been originated by those very men who wandered for years amid the complexities of geology, often without so much as an idea of their labours; and these technological terms are the results of their patient investigations and long years of experience."

We cannot always agree with the author however, who, it is only just to say, follows closely to received opinions, some of which, it is well known, we have long been disposed to contest. One of these points to which he adheres is the old igneous origin of certain crystalline rocks:—

"We may learn from this," he says, "that the various rocks of *igneous* origin owe their numerous modifications to the circumstances under which they have solidified, not to any difference in their origin; the on'y changes being what they have lost or what they may have gained in passing through previous formed rocks. Had it not been for the outburst of such igneous rocks, our 'old and craggy earth,' as Cowper calls it, would have been full of yawning chasms, and its solid crust would have presented an appearance something similar to a clay-bank that has been exposed to a July sun. But the fluid molten matter has been squirted from beneath into all the fissures which had been formed from the contraction of the masses after their formation, and has bound and cemented them together. Nay, were it not for the existence of such outlets to the *fiery* reservoir below *these volcanic vents*, our world could not have lived out half its days. These have been, in all stages of its history, the *safety-valves* to let off the superfluous potency, instead of being *pent up and exploding the thin shell formed by the stratified rocks*, or causing the earth to come to *an untimely end by its disjointed continents wandering in several orbits* through space, in a manner similar to that hypothetical planet Pluto."

Mr. Taylor has said here nothing new which others have not said before, but the passages we have set in italics will show the incongruity of the items of which this igneous theory is compounded; for how that which has *cemented* together the fractures of the shell of our earth can be a means of *outlet* for the *liquid* matter beneath, is not clearer than is the source of the heat that made and maintains a molten core attributed to our planet. As to the origin of these so-called igneous rocks, just let us put againt these old parrot-repeated dicta what Sterry-Hunt, one of the best of modern geologists, has recently written in his "Contributions to Lithology," in Silliman's Journal.

"I have already, in other places, expressed the opinion that the various eruptive rocks have had no other origin than the softening and displacement of sedimentary deposits; and have thus their sources *within the lower portions of the earth's stratified covering, and not beneath it.* The theory which conceives them to have been derived from a portion of the interior of the earth still retaining its supposed primitive condition of igneous fluidity, is, in my opinion, untenable. It is not here the place to discuss the more or less ingenious speculations of Phillips, Durocher, and Bunsen as to the constitution of this supposed fluid centre, nor the more elaborate hypothesis of Sartorius von Walterhausen as to the composition and arrangement of the matters in this imaginary reservoir of Plutonic rocks. *The immense variety presented in the composition of eruptive masses, presents a strong argument against the notion that they are derived*, as these writers have supposed, *from two or more zones of molten matter, differing in composition and density, and lying everywhere beneath the solid crust of the earth*, which, in opposition to the views of many modern mathematicians and physicists, the school of geologists just referred to regard as a shell of very limited thickness. The view which I adopt is one, the merit of which belongs, I believe, to Christian Keferstein, who, in his 'Naturgeschichte des Erdkörpers,' published in 1834, maintained that *all the unstratified rocks from granite to lava are products of the transformation of sedimentary strata, in part very recent; and that there is no well-defined line to be drawn between Neptunian and Volcanic rocks, since they pass into each other.*"

The general tenor of Mr. Taylor's Essays however is very good, and his book is a very readable and useful one, especially in all that he has to say on the local geology of those districts in which he has resided. Thus the accounts of the Lancashire coal-field and of the strata in the vicinity of Manchester, are exceedingly interesting, while the illustrations of fossil plants and shells are very appropriately selected.

Flora of Surrey. By J. A. Brewer. London: Van Voorst. 1863.

This is a full and comprehensive catalogue of the flowering plants and ferns found in the county, with the localities of the rarer species, from the manuscripts of the late J. D. Salmon, F.L.S., and from other sources, compiled for the Holmesdale Natural History Club, at Reigate, by Mr. Brewer. The work is in small octavo, and contains nearly 370 pages, and two large excellent folded maps—one of the geology, the other botanical provinces; and it will be useful to add, that the geological map can be purchased separately in sheet, case, or on rollers. In accordance with Mr. Salmon's plan, the county has been divided into nine districts or divisions, for the purpose of more readily ascertaining the particular localities of the plants. The geological map has been prepared and coloured from one drawn by Mr. Prestwich, and we need not say will consequently be acceptable to all who are interested in the geology of the county. The three principal groups of geological strata are the Wealden, the Cretaceous, and the London Clay; Reading and Woolwich beds, Thanet sands, and other Tertiary beds surmounting the Chalk. Here and there, especially along the river-valleys, are accumulations of gravel and drift deposits. The whole of the north-eastern division of the county belongs to the London Clay formation, and is comparatively low; and consequently the various elevations on the north side, such as Denmark, Herne, and Richmond hills, although of no great elevation, still command extensive prospects. It also forms the hills running southward along the Kentish border by New Cross, Forest Hill, Sydenham, and Norwood. It is estimated that in some situations the London Clay is nearly a thousand feet thick, but that that portion which extends into Surrey does not exceed 500 or 600 feet. The principal feature of the northern district is again the London Clay, covered in places by the Bagshot sand, as in the vicinity of Esher. The whole of the north-western division consists of London Clay, for the most part covered with the Bagshot sand, and presenting a poor, hungry, unimprovable soil, as at Bagshot heath itself, which lies within this region. Large masses of the siliceous sandstone known as "grey wethers" are found there. The entire eastern division is occupied by the Cretaceous rocks, with the exception of a small portion of the Reading and Woolwich beds, and the Thanet sands, which occur to the east of Croydon. The Chalk occupies a considerable area, and forms a portion of the North Downs. The Upper Greensand, or freestone, forms the foot of the escarpment of the Downs, and extends from Godstone by Merstham and Reigate through the county into Hampshire. The central division is principally occupied by the Chalk, but its north-west angle shows London Clay, which at Ockham Heath and Send is covered with Bagshot sand; and a narrow slip of the Woolwich and Reading beds runs along the northern margin of the Chalk. The western division is principally occupied by London Clay, but a narrow ridge of chalk, known as the "Hog's back," runs almost the whole length of the southern boundary, and at the foot of which the Gault and Upper Greensand crop out. The south-eastern division is, with the exception of a narrow strip of Lower Greensand on the north, occupied by the Weald Clay—the Hastings sand appearing at the south-eastern corner. The southern division is equally divided between the Greensand and Weald Clay. The principal stratum in the south-western division is the Lower Greensand.

The following is a brief analysis of the distribution of the plants:—The total number of species occurring is 117; the number confined to the valley alluvium, 7; to the superficial gravels, 19; to the Bagshot sands, 9; to the London Clay, 14; to the Reading and Woolwich beds, 2; to the Chalk, 55; to the Upper Greensand and Gault, 5; and to the Lower Greensand, 28.

Descriptive Catalogue of the Salisbury and South Wilts Museum. Salisbury: Bennett. 1864.

Proceedings of the Inauguration of the Salisbury and South Wilts Museum. Salisbury: Bennett. 1864.

The establishment of a new museum is always a matter of note, but that of an important one in so remarkable a district, both archæologically and geologically, as Wiltshire, is unusually interesting. The inauguration took place in January of the present year, an account of which was duly sent to us, but want of space prevented our noticing it at the time. We also received an illustrated descriptive catalogue of 112 pages and 14 plates, which is a very model of what should be done for every local museum. The stone, bronze, and early iron objects have been catalogued by Mr. E. T. Stevens; the mediæval series and the pottery, by Mr. Nightingale; the mediæval seals, by Mr. W. Ormond; the mammalian remains of the Pleistocene period, by our talented contributor Dr. H. P. Blackmore, and the birds by Mr. Henry Blackmore. It should be distinctly understood that this is not a mere bare enumeration of the objects deposited in the museum, but that popular and intelligible explanations of the uses, objects, purposes, and nature of the objects registered, are freely and fully appended. Too much praise cannot be given to those who have thus striven to make the Salisbury Museum instructive to visitors of all denominations and degrees of education and intelligence.

Geological Survey of Canada.

The Report of Progress of this most important survey, from its commencement to 1863, illustrated with nearly five hundred woodcuts, has been produced by the officers, Sir William Logan, Director, Mr. Alexander Murray, Assistant Geologist, Mr. T. Sterry Hunt, Chemist and Mineralogist, and Mr. Billings, Palæontologist. A noble volume it is, of all but a thousand pages, worthy of the clever, active, and indefatigable Director, of his able staff, and creditable in production to the printer and the engraver; for Montreal, in this respect, could not be expected to rival our own metropolis, but the typography and press-work are remarkably good for colonial work. An atlas of maps is to accompany the volume, but is not yet complete. The Geological Survey of Canada was instituted by the Provincial Government in 1843, and since then results have from time to time been submitted to the Legislature and published. The present volume contains, in a perfect form, the substance of those periodical reports, with a great deal of original matter; and the work, as now presented, is a grand record of the full labours of the Survey.

Flora Belfastiensis. By Ralph Tate, F.G.S.

As Belfast was without a complete local Flora, the little book before us will supply a decided want, and emanating from a gentleman who is an excellent geologist as well as a botanist, those special points which give the peculiar value which local Floras have to the field-geologist, will naturally have received due and more than usual attention. The list of plants seems to us a very full and perfect one; but it is the introductory description of the physical features of the district that geologists will find most instructive. It is well known that relations exist between the various soils and the plants which grow upon them; but as drift and other superficial deposits are commonly widely spread over many areas, it follows that the classes of plants growing over the surface do not necessarily, and very commonly do not, represent the varieties of the rocks constituting the main geological structure of the county. Wherever a diversity of rock occurs, we have a corresponding diversity of species, and these again are increased or diminished in numbers in accordance with the amount of disintegration suffered, the capacity to imbibe water, and other conditions of the rocks. The district under consideration is divided by the Belfast Lough and the river Lagan into two well-marked sections, both as to the geological strata and as to geographical relations. The northern section is occupied by the Belfast Hill Range, the basis of which is the Keuper formation rising in a steep incline. The New Red is surmounted by the Lias, the Upper Cretaceous rocks and Basalt forming a bold escarpment extending from Whitehead to Lisburn, with an average elevation of a thousand feet, from the heights of which the land slopes gently inland, forming plateaus of great extent. The southern section, excepting some patches of the newest Tertiaries in the neighbourhood of Bangor and in the Knock Valley, is composed of Palæozoic rocks. Surmounting the Silurians are the freestones of the Old Red Sandstone, in some places capped by Greenstone Porphyry, a mere strip of Carboniferous Limestone occurring at Castle-Espie. Beds of the Permian age occupy the coast-line at Caltra. The districts of Lagan, Knock, Ballyaholly present extensive marshes, and peat-bogs are encountered at high elevations in the northern section, as on the Black Mountains. With a region so varied in its geological surface, and so diversified in its physical aspects, we might expect to find a great variety and diversity of plants; and so it is: Mr. Tate records 602 species.

Professor Phillips's 'Guide to Geology.'

There is no book we know of more worthy to be put in the hands of beginners in geology than the pretty work of Professor Phillips, the fifth edition of which is now before us, nor is there any more fitted for giving a rudimentary knowledge to the general public, especially such as wish to get sufficient knowledge to understand the main discussions of such importance as are now being carried on. Professor Phillips's long experience as a teacher has well fitted him for giving such instruction. He is an acute thinker, a voluble speaker, and possesses a love of his science and great earnestness. There is a tendency in his thinking towards speculativeness which makes his writings more suitable to the understanding of ordinarily educated persons, and peculiarly pleasant to those who wish to understand the controversies of the day. At the same time the main philosophical principles of geology are not neglected, and the object of the science, the earth's condition as a planet considered, and the nature and character of the primitive land discussed; the elementary substances which enter into the composition of rocks, their stratigraphical arrangement given, the origin of rocks stratified and unstratified, the physical geography and general structure of the earth pointed out. The subaqueous production of land, its elevation, the relative antiquity of its various portions, the changes of climate, the series of life and vegetation which have existed in past time, the various proposed methods of estimating the lapses of geological time, are other subjects equally well and clearly treated, the last two chapters being devoted to lithology, and to tables and calculations.

INDEX.

LIST OF PLATES.

LIST OF WOODCUTS.

END OF VOL. VII.

JOHN EDWARD TAYLOR, PRINTER,
LITTLE QUEEN STREET, LINCOLN'S INN FIELDS.

Date Due

FEB 1970	
JUN 1970	
~~JAN 77~~	